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Effect of Phase 1 and Phase 2 Gasolines on Evaporative and Exhaust Emissions from Light Duty Vehicles

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The objective of this study was to investigate the emissions impact of reformulated gasolines on evaporative and exhaust emissions from a small fleet of light-duty automobiles. Three gasolines were used: pre-1992 California gasoline, California Phase 1 gasoline, and California Phase 2 gasoline. The pre-1992 fuel was blended to specifications representative of gasolines sold in California prior to the introduction of Phase 1 gasoline in 1992, while the Phase 1 and 2 fuels were blended to the specifications of the California regulations, including the addition of oxygenates such as methyl tertiary butyl ether (MTBE) or ethanol. The vehicles were tested over the Federal Test Procedure (FTP) for exhaust emissions, and over the FTP and the Air Resources Board's (ARB's) extended high temperature evaporative emissions test procedure for evaporative emissions. The test results showed a general reduction of hydrocarbon and carbon monoxide exhaust emissions for all gasoline blends, while evaporative emissions were increased for the ethanol blend.

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ABSTRACT

Automotive Testing Laboratories, Inc. performed a study of evaporative and exhaust emissions generated by gasoline powered vehicles using California fuels. The four fuels used in this study were designed to represent a California pre-1992 Base gasoline, 1992 California Phase 1 gasoline, 1996 California Phase 2 gasoline (MTBE), and a Splash Blended Ethanol gasoline. The Splash Blended Ethanol gasoline used the same hydrocarbon base as the California Phase 2 gasoline and was included to examine the effects of allowing a one psi exemption for Reid Vapor Pressure (RVP) (for the addition of ethanol as an oxygenate) which was under consideration in California at the time of the proposal. Eleven conventional vehicles covering a range of technologies (1973-1990) were tested under the then new California Test Procedure for evaporative emissions (ARB mail-out 92-10). Exhaust and evaporative emissions were analyzed. Selected tests were speciated for hydrocarbons, aldehydes, and/or alcohols. The mass emissions and toxic results were analyzed to determine the impact of the fuels on exhaust and evaporative emissions. Most of the conclusions drawn from the data produced by this study were well supported by previous studies. However, there was a statistically significant result which did not conform to the trends of previous studies that investigated the effects of fuel formulation on emissions. Both the 1996 California Phase 2 and the Splash Blended Ethanol fuels tended to produce lower exhaust NOx emissions when compared to the pre-1992 California Base and the 1992 California Phase 1 fuels. The 1996 California Phase 2 fuel exhaust NOx reductions were determined to be statistically significant.

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Automotive Testing Laboratories, Inc. would like to thank all those who have contributed to the successful completion and fulfillment of this contract. The associated ARB staff at both the El Monte and Sacramento offices were instrumental to the completion of this body of work, especially Ms. Annette Hebert of the Mobile Source Division. Additionally, ATL would like to acknowledge the efforts of Patrick Donnally Associates of San Ramon, CA. for their work as ATL's subcontractor for the statistical analysis of the data.

This draft report was submitted in partial fulfillment of A132-183 by Automotive Testing Laboratories, Inc. under the sponsorship of the California Air Resources Board and the South Coast Air Quality Management District. The vehicle testing work was completed as of January, 1994.

2. *Fuels.* The four fuels used in this study were designed to represent a California pre-1992 Base gasoline, a California 1992 Phase 1 gasoline, a California 1996 Phase 2 gasoline with MTBE[4], and a Splash Blended Ethanol fuel. The California Phase 2 fuel incorporated 10.8 vol% MTBE and the Splash Blended Ethanol fuel contained 5.5 vol% ethanol. A level of 10.8 vol% MTBE or 5.5 vol% ethanol will produce approximately 2.0 wt% oxygen content. The Splash Blended Ethanol gasoline used the same hydrocarbon base as the California Phase 2 fuel with MTBE and was included to examine the effects of allowing a 1.0 psi exemption for Reid Vapor Pressure (RVP). The ARB was considering allowing a 1.0 RVP exemption to accommodate the splash blending of ethanol into 7.8 RVP gasoline to meet the oxygenate requirements.

A complete listing of the test fuel specifications is included as Appendix B. Each of the test fuels was sent to an independent laboratory for complete analysis. The results of these independent fuel analyses are summarized in Appendix C. Hereafter, the following abbreviations will be used to refer to the test fuels:

Test Fuel	Abbreviation
California pre-1992 Base fuel	Base
California 1992 Phase 1 fuel	Phase 1
California 1996 Phase 2 fuel	Phase 2
Splash Blended Ethanol fuel	SBE

3. *Test Matrix.* The data generated throughout the course of the test program consisted of the exhaust emissions and evaporative emissions portions of the California Evaporative Emission Test Procedure[5] (included as Appendix D). Testing included thorough preconditioning, a standard FTP exhaust emissions test, a Running Loss and Hot Soak test performed at 105°F, and a three day (72 hour) diurnal evaporative emissions test (also referred to in this document as the VT SHED test).

All eleven vehicles were tested on the Base, Phase 1, and Phase 2 gasolines. Six of the eleven vehicles were tested on SBE. All FTP and Running Loss tests included a full complement of chemical speciation analyses: Hydrocarbon (HC), carbonyl and, for SBE only, alcohol speciation on FTP tests plus HC and, for SBE only, alcohol speciation on the

[4] MTBE: methyl t-butyl ether

[5] At the inception of the test program the current California Evaporative Emission Test Procedure was detailed in ARB Mail-Out 92-10. Mail-Out 92-10 was used as the guideline for all testing throughout the program.

I. SUMMARY AND CONCLUSIONS

A. OBJECTIVE

The objective of this study was to determine the effects of California Phase 1 and Phase 2 reformulated gasoline on evaporative and exhaust emissions from light duty vehicles. Both evaporative and exhaust tests were performed on a fleet of in-use California emissions-certified vehicles drawn from a wide range of emission control technologies. The test results obtained were examined statistically to address three specific questions concerning the use of Phase 1 and Phase 2 fuels:

1. What is the response of a variety of in-use vehicle technologies to changes in fuel composition and the resulting changes in physical properties?

2. Are air toxics such as 1,3-butadiene, benzene, formaldehyde, and acetaldehyde generated by the use of oxygenates to an extent which offsets observed reductions in regulated pollutants?[1]

3. What evaporative and exhaust effects are noted at elevated summertime temperatures typical of Southern California?[2]

B. SCOPE

1. Vehicles. The ten California-certified vehicles used in the program were previously procured for a California Air Resources Board (ARB) program performed at ATL, "Effect of Use of Low Oxygenate Gasoline Blends upon Emissions from California Vehicles". One additional 49 state vehicle was supplied by Ford for use during this program.[3] To the extent possible, the vehicles were unmodified to allow representation of actual in-use conditions. Key specifications of the vehicle fleet are given in Appendix A.

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[1] The intent of this question is not to assess whether or not any increase in one pollutant is acceptable in view of a decrease in another pollutant.

[2] The evaporative testing portion of this program provides a good indication of the test fuels performance at an elevated test temperature (105°F). However, the exhaust emission testing was performed at 75 °F as was specified in the Evaporative Emission testing regulations, ARB mail-out 92-10.

[3] The Ford vehicle (13a) was used at the request of ARB to replace an ARB supplied flex/fuel vehicle which was determined to be of a hybrid design and thus not suited to the scope of this program.

Table 1 Test Matrix - Speciation[a]

changes had a measurable effect on both evaporative and exhaust emissions for test results with this vehicle fleet. The differences in emission levels of all measured exhaust emission components can be at least partially explained by the differences in composition of the individual test fuels. Most of the conclusions which can be drawn from this data are well supported by previously published studies. This study has confirmed:

- In general, the use of Phase 2 reduced HC, CO, benzene and 1,3-butadiene emissions, compared to Phase 1 and Base.
- SBE reduced CO, benzene and 1,3-butadiene emissions, but not as well as Phase 2, compared to Phase 1 and Base.
- Fuels with lower benzene and aromatic content produced less emissions of benzene than fuels with higher benzene and aromatic content.
- Phase 2 produced more formaldehyde emissions and SBE produced more acetaldehyde emissions than the non-oxygenated fuels, although the overall toxicity of exhaust emissions due to the use of Phase 2 is not expected to increase.[7]
- All of the significant evaporative effects (found in Running Loss and VT SHED tests only) followed changes in RVP.

However, results which do not conform to the trends found in previous research regarding the effect of fuel formulation on emissions include:

- Both Phase 2 and SBE tended to produce lower NO_X in this test fleet (significantly for Phase 2, not significantly for SBE). Recent work by Auto/Oil[8] indicated the use of MTBE or ethanol may increase the level of NO_X emissions.
- Because of the variability in the data for CO_2 emissions, the effect of dilution of energy content by the addition of oxygenates (and corresponding reduction in volumetric fuel economy) was not observed as a statistically significant trend in this work. Because both MTBE and ethanol have a lower energy content (Btu/lb) than hydrocarbon-only gasoline, the Phase 2 test fuel (containing 10.7 vol% MTBE) and SBE (containing 5.7 vol% ethanol) also had lower energy content than the BASE test

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[7] State of California Air Resources Board, "California Phase 2 Reformulated Gasoline Specifications, Technical Support Document", October 4, 1991.
[8] Robert M. Reuter, et al., "Effects of Oxygenated Fuels and RVP on Automotive Emissions - Auto/Oil Air Quality Improvement Program", SAE Paper #920326

fuel or the Phase 1 test fuel (Appendix C). Thus, all things being equal, one might expect fuel economy to be affected, but this was not the case here.

Are air toxics such as 1,3-butadiene, benzene, formaldehyde, and acetaldehyde generated by the use of oxygenates to an extent which offsets observed reductions in regulated pollutants? Although the word offset was originally used in the proposal, this study was not designed or intended to be viewed as investigating one type of pollutant as a trade-off for another. Such an evaluation implies an ability to quantify the air quality detriment of air toxics such as 1,3-butadiene, benzene, formaldehyde, and acetaldehyde versus HC, CO, and NO_X, and this type of evaluation was not within the scope of the program. Most of the statistically significant fuel effects found for this program can be directly attributed to fuel composition changes, although this study was not designed to specifically compare the effects of oxygenated versus non-oxygenated fuels.

- In general, both the 1996 California Phase 2 and the Splash Blended Ethanol fuels produced lower levels of all regulated exhaust emissions than the pre-1992 California Base and the 1992 California Phase 1 fuels (except formaldehyde).
- Formaldehyde (for both Phase 2 and SBE) and acetaldehyde (for SBE only) were increased compared to the Base and Phase 1 fuels. However there is not expected to be an increase in the overall toxicity of exhaust emissions due to the use of Phase 2 gasoline.[7]
- 1,3-butadiene and benzene emissions were consistently reduced by the use of SBE and especially Phase 2, compared to the Base and Phase 1 fuels.

What evaporative and exhaust effects are noted at elevated summertime temperatures typical of Southern California? The evaporative testing portion of this program provides a good indication of the test fuels performance at an elevated test temperature (105°). However, the exhaust emission testing was performed at 75°F as was specified in the Evaporative Emission testing regulations, ARB mail-out 92-10. Thus, the scope of work only partially addresses the issue of emissions at elevated summertime temperatures. All of the evaporative emissions test data (Running Loss, Hot Soak, VT SHED) appeared to be explainable in terms of the RVP of the test fuel. The greater the RVP of the fuel, the higher the evaporative emissions during the tests.

- The Phase 2 fuel reduced evaporative HC emissions by 28%, 6%, and 60% when compared to the other test fuels (Base, Phase 1, SBE) for the Running Loss portion of the test.
- None of the test fuels had a statistically significant impact on evaporative Running Loss benzene emissions.
- Phase 2 fuel reduced evaporative Hot Soak HC emissions by 70%, 26%, and 89% when compared to the Base, Phase 1, and SBE fuels, respectively. The results from this program for Phase 2 versus Base and Phase 2 versus SBE were significant only at the 90% level.
- Statistically significant evaporative HC emission reductions were observed for Phase 2 fuel in the VT SHED tests (51%, 33%, and 45% versus Base, Phase 1 and SBE, respectively), for three day average.
- The VT SHED extended evaporative test was the only portion of the test program which showed a statistically significant improvement in the emissions produced by the Phase 1 fuel when compared to Base (32% average evaporative HC reduction for each day of the extended evaporative test).

II. SCOPE OF WORK

A. BACKGROUND

The addition of oxygenates and other changes in the chemistry of fuels have emerged as options for air quality planners to promote reductions in HC and CO inventories from in-use vehicles. However, little is known about the effect of fuel composition on the California extended evaporative procedure which includes Running Loss, Hot Soak, and diurnal evaporative emissions as well as exhaust FTP emissions. The questions which must be answered are:

- What is the response of a variety of in use vehicle technologies to these changes in fuel composition and the resulting changes in physical properties?
- Are air toxics such as 1,3-butadiene, benzene, formaldehyde, and acetaldehyde generated by the use of oxygenates to an extent which offsets observed reductions in regulated pollutants?
- What evaporative and exhaust effects are noted at elevated summertime temperatures typical of Southern California?

The objective of this study was to determine the effects of the use of California commercial fuels on both regulated emissions (HC, CO, NO_x, formaldehyde) and unregulated emissions (benzene, acetaldehyde, and 1,3-butadiene). This study used a combination of conventional and new collection techniques to quantify the evaporative and exhaust emissions from both current and future California fuels. The test protocol used was the California Evaporative Emission Test Procedure detailed in ARB Mail-out 92-10. Both exhaust and evaporative emissions were measured. The test results obtained were examined statistically to address the three specific questions described above.

The vehicles selected for this study included a cross section of past and current emission control technologies. The test fuels for the program represented an overview of California commercial fuels including a pre-1992 Base fuel and a 1996 California Phase 2 fuel with MTBE. A California 1992 Phase 1 fuel and a Splash Blended Ethanol fuel made from the same hydrocarbon base as the Phase 2 fuel were included to complete the test fuel matrix.

The vehicle testing was performed at ATL's Ohio Laboratory (East Liberty, Ohio). Vehicle testing was completed in January, 1994. The data analysis was performed under subcontract by Patrick Donnally Associates (San Ramone, CA) and was completed in the fall of 1994.

B. TEST VEHICLES

1. Vehicle Description. Eleven vehicles representing the three major domestic manufacturers (Chrysler, Ford, and General Motors) and two import manufacturers (Toyota and Honda) were procured for this program. Originally, one flex-fuel vehicle supplied by ARB was to be part of this program. However, it was later determined that the flex-fuel vehicle (1991 Ford Taurus) was a hybrid design and unsuitable for this program. According to Ford, the flex-fuel Taurus was intended to be an exhaust emissions vehicle only. During the evaporative portions of the test procedure the flex-fuel Taurus would not vent the fuel tank to the canister in sufficient amounts to relieve fuel tank pressure. This excessive fuel tank pressure produced evaporative emissions which were determined to be un-typical of this vehicle class and thus unsuitable for the primary focus of this program. A 1989 Taurus was supplied by Ford as a replacement test vehicle and the flex-fuel Taurus was returned to ARB. All of the vehicles, except for the Taurus supplied by Ford, were previously procured for an ARB program performed at ATL, "Effect of Use of Low Oxygenate Gasoline Blends upon Emissions from California Vehicles".

2. Vehicle Maintenance. Test vehicles were to be maintained in correct working order and any defective parts were replaced prior to testing. All the test vehicles received a complete fluid change (engine oil, transmission fluid, and engine coolant) and air-conditioning system recharge. The vehicle exhaust systems were repaired and sealed. In most cases, the entire exhaust tubing system from the exhaust manifold and back was replaced. None of the vehicle catalysts were replaced. Following the exhaust system repairs a mock Running Loss test was performed on each vehicle prior to entering the program. This test was performed to insure than the exhaust system was not leaking exhaust gases into the test chamber. A raw exhaust leak into the Running Loss test chamber presents a twofold problem concerning enclosure testing. First, it is an obvious safety issue when testing is performed by the enclosure method as it is at ATL. Second, any exhaust hydrocarbons present in the test enclosure will confound the measurement of evaporative HC emissions during the test.

The only exception to the repair policy concerned the Toyota Celica's air-conditioning system. At the inception of the test program the Celica was identified as a non-air-conditioned vehicle. During the pretest inspection, it was discovered that every air-conditioning-related component had been removed from the vehicle prior to acquisition by ATL. At the direction of ARB, the Celica's air-conditioning system was not replaced. It was obvious that the Celica had been operating for quite some time without a functioning air-conditioning system.

Care was taken to eliminate any periods of vehicle inactivity or "downtime" prior to a vehicle entering its initial test sequence. Prior to entering testing, or following an extended amount of downtime during the test fuel randomization schedule, each vehicle was driven an additional 10 - 20 road miles prior to standard preconditioning.

C. TEST FUELS

The fuels designed and blended for this program were representative of commercial fuels available, or expected to be available, in the past, present, and future in California. The pre-1992 Base fuel was a well-characterized hydrocarbon-only gasoline typical of fuel sold in California just prior to the start of the program. It had a higher volatility (nine psi, max.) and more "reactive" (ozone precursors) components, such as aromatics and olefins, than current regulations allow. The 1992 Phase 1 regulations limited volatility to 7.8 psi, max., and a requirement for deposit control additives was implemented, with all other characteristics of commercial fuel unchanged. Therefore the test fuel labeled Phase 1 was quite similar to the Base test fuel, except for RVP (and related changes in the distillation range) and the inclusion of a deposit control additive.

The Phase 2 gasoline regulations were promulgated (with an implementation scheduled for March of 1996) based upon the recognition that fuel composition (beyond volatility control) could have a significant impact on air quality, with the major concern being the production of ozone precursors from the evaporation of, or combustion of, commercial gasoline in light duty vehicles. The Phase 2 specification addresses reductions in "heavy ends" (controlled by limiting T_{50} and T_{90}, aromatic hydrocarbons), and diene production (by limiting olefins). Catalyst activity in general is believed to be affected by fuel sulfur, so Phase 2 gasolines are allowed to contain very little sulfur compared to earlier fuels (40 ppm versus as much as 300 ppm), and of course, no intentionally added lead or phosphorus. Benzene, in addition to being moderately photoreactive, is considered an air toxic (carcinogen) and therefore is also limited in Phase 2 fuels. The addition of oxygenates was specified to help reduce carbon monoxide emissions, especially from the relatively larger proportion of older vehicles in the state. At the time the details of this test program were under development, there was a concern that increases in NO_X emissions accompanied oxygenate addition and that effect increased non linearly above 2.0 wt% oxygen. Therefore the maximum allowable oxygen content for California Phase 2 fuels would be set at 2.0 wt% (2.2 wt% maximum, to allow for testing tolerances). Further, it had not yet been decided whether or not fuel blenders would be allowed a one psi waiver in order to use ethanol as the source of oxygen. For this investigation the remaining two test fuels were designed to the Phase 2 specifications, with 11 vol% MTBE providing the oxygen for the test fuel labeled Phase 2, and 5.75 vol% ethanol providing the oxygen in the test fuel labeled SBE (Splash-Blended Ethanol). Actually, the same hydrocarbon base was used for both Phase 2-type test fuels and the oxygenates were added without volatility adjustment, i.e. "splash-blended". MTBE addition had only a very slight volatility impact on the hydrocarbon base, while the ethanol caused about a one psi increase in RVP.

The fuel blender selected for this program was Phillips 66 Company, Borger, Texas. The four test fuels were blended in small quantities, inspected for composition and physical properties by the blender and tested again at one to three other laboratories, reblended and retested, if necessary, before they were scaled-up to tank blends. When the full scale blends had been made, tested, and the data accepted by the ARB, they were divided into drums and shipped to ATL.

Each drum of fuel was sampled for a RVP determination upon initial opening and again at the end of its use. The RVP was determined using a Grabner Model CCA-VPS vapor pressure instrument using the ASTM D5191-91 method of sequential cooling to 0°C (in ice), venting, and shaking to fully saturate the sample with air prior to the RVP measurement. The equation used to calculate the RVP in units of psi was:

$$RVP(Equivalent) = (0.965 \times P(total)) - 0.55$$

which is specified in Method D5191-91. The average vapor pressures found for the fuel drum monitoring can be found in Table 2.

Table 2 Average Test Fuel RVP Measurement Results

Test Fuel	Target RVP Range, psi	Average Measured Top of Barrel RVP, psi	Average Measured Bottom of Barrel RVP, psi
Base	8.5 - 9.1	8.68	8.44
Phase 1	7.4 - 8.0	7.73	7.51
Phase 2	6.5 - 7.1	6.61	6.60
SBE	7.4 - 8.0	7.64	7.56

D. TESTING MATRIX

Each test vehicle in this program was tested on either three or four of the test fuels over the course of the California Evaporative Emission Test Procedure detailed in ARB Mail-out 92-10. All eleven vehicles were tested on Base, Phase 1, and Phase 2. Six of the eleven vehicles were also tested on the SBE fuel. Each vehicle was assigned a random test fuel sequence for testing. The test fuel randomization sequence is included as Table 3.

Table 3 Test Fuel Randomization Sequence

Vehicle	First Test	Second Test	Third Test	Fourth Test (if req.)
1	Phase 2	Base	Phase 1	SBE
2	Phase 2	SBE	Base	Phase 1
3	Phase 2	Phase 1	Base	--
5	SBE	Base	Phase 2	Phase 1
7	Phase 1	Base	Phase 2	--
8	Base	Phase 1	Phase 2	--
9	Base	Phase 1	SBE	Phase 2
10	Phase 1	Phase 2	Base	--
11	Base	Phase 2	Phase 1	--
12	SBE	Phase 1	Phase 2	Base
13a	SBE	Phase 2	Phase 1	Base

In addition to the evaporative emission procedures two QC FTP tests were performed on each vehicle during the course of testing. These QC FTPs were performed on the first test fuel in that particular vehicles test matrix and followed both the second test and the final test in the randomization matrix. These results were compared to the original FTP test results for that vehicle to monitor vehicle drift throughout the testing portion of the program. The results of the QC FTPs are included as Table 4. The QC FTPs were not

Table 4 QC FTP Results

Veh#	Fuel	First FTP, g/mile HC	CO	NOx	First QC FTP, g/mile HC	CO	NOx	Second QC FTP, g/mile HC	CO	NOx
1	Phase 2	0.14	0.84	0.39	0.16	1.47	0.57	0.16	1.25	0.47
2	Phase 2	1.09	11.62	3.84	1.39	9.63	3.89	1.48	11.88	4.02
3	Phase 1	2.11	18.28	3.23	2.33	18.11	3.07	---	---	---
3	Phase 2	2.18	15.71	2.96	---	---	---	2.00	11.97	3.19
5	SBE	0.16	2.43	0.41	0.20	2.67	0.47	0.14	2.22	0.44
7	Phase 1	1.09	10.24	2.34	1.06	11.08	2.34	0.99	8.92	2.35
8	Base	0.38	3.81	1.02	0.51	4.88	1.00	0.45	4.74	1.05
9	Base	0.29	5.46	0.25	0.29	6.27	0.25	0.24	4.96	0.25
10	Phase 1	1.65	13.73	1.67	1.92	17.22	1.65	1.80	13.32	1.81
11	Base	1.05	15.39	1.46	0.98	13.79	1.42	0.97	15.80	1.44
12	SBE	1.49	15.33	1.06	1.40	20.93	0.98	1.35	19.95	1.08
13a	SBE	0.28	2.74	0.55	0.23	1.90	0.51	0.28	2.59	0.63

Note: Vehicle 3 (Oldsmobile Cutlass) had one QC FTP on Phase 1 fuel and one QC FTP on Phase 2 fuel.

intended to be used in the statistical analysis of the data. Since the decision was made to test each vehicle through the test fuel matrix before starting the next vehicle, the time span of each vehicle's participation in the testing program was limited to a few weeks. Originally, a full vehicle/fuel randomization schedule was discussed which would have required the test vehicle participation to be on the order of months rather than weeks. The longer test schedule may have necessitated the statistical analysis of the QC FTP test results for possible vehicle drift. However, since neither the QC FTPs nor the statistical analysis of the QC FTPs were included within the scope of work for this program and since each vehicle's participation was limited to a few weeks, statistical analysis of the QC FTP data was omitted. Visual inspection of the Table 4 data shows no indications that the exhaust emissions of any of the vehicles changed more than expected (within typical test to test repeatability limits) over the testing interval.

Following the final QC check on each vehicle a single purge flow measurement was performed to help characterize the vehicles' purge strategy . The vehicle performed two UDDS cycles with a two minute idle in between each UDDS. Purge flow from the canister to the engine was monitored and recorded. The purge flow results for each vehicle are reported in Table 5.

Table 5 Purge Flow Measurement

Vehicle #	1	2	3	5	7
	Cumulative Purge Flow (liters)				
End of Bag 1	122.3	16.1	39.0	68.4	64.3
End of 1st UDDS	314.9	39.2	68.9	149.6	134.6
End of 2 min idle	325.5	42.7	71.0	150.6	136.6
End of Bag 3	459.9	57.6	110.0	220.9	200.3
End of 2nd UDDS	668.3	80.1	139.9	300.5	271.5

Vehicle #	8	9	10	11	12	13a
End of Bag 1	271.0	47.0	17.3	168.4	52.1	96.2
End of 1st UDDS	745.0	95.5	32.4	446.7	138.5	289.7
End of 2 min idle	814.2	96.8	34.2	489.4	145.2	300.1
End of Bag 3	1082.0	142.1	50.6	663.2	196.4	432.6
End of 2nd UDDS	1551.0	194.0	67.4	932.6	283.2	622.3

E. LIMITATIONS OF THE STUDY

Because this study addressed such a broad scope of experimental parameters, it was inevitable that the limitations imposed on its experimental design would result in some limitations in the breadth and strength of the conclusions that could be made from the resulting data. The main limitation, of course, was the size and distribution of the vehicle fleet. A larger and more diverse vehicle selection would have resulted in more vehicles within each emission technology group and, consequently, a more definitive statistical interpretation of the data. For instance, the vehicle fleet contains only one vehicle without a catalyst, only two oxidation catalyst vehicles, and only one throttle body injection vehicle. An additional limitation was that SBE was only tested in six of the eleven vehicles. The reduced number of tests on SBE relative to the other test fuels severely limited the availability of SBE data to be examined statistically. Since all the data from this program was analyzed using the paired-t test approach, each category of the comparison (technology group or test fuel) was required to contain at least two samples. In the case of the statistical analysis of the exhaust and evaporative emissions by technology group, a majority of the SBE data could not be analyzed because of this restriction. As seen in Table 6 the only exhaust emissions technology groups which could be analyzed statistically for SBE were the TWC/Carb or TBI and the TWC/FI technology groups. The same problem was magnified in terms of the evaporative emissions technology groups as seen in Table 7. Of the six vehicles tested on SBE for evaporative

Table 6 Exhaust Emissions Technology Groups

Technology Group[a]	Vehicle(s)[b]
No Catalyst/Carbureted (No Cat/Carb)	3*
Oxidation Catalyst/Carbureted (Oxy Cat/Carb)	10*, 12
Three Way Catalyst/Carbureted or TBI[c] (TWC/Carb or TBI)	2, 7*, 9, 11*
Three Way Catalyst/Fuel Injected (TWC/FI)	1, 5, 8*, 13a

[a] The Exhaust Emissions Technology Groups are a classification based on the vehicle's catalyst type and fuel metering system.
[b] Vehicles with * were not tested on SBE.
[c] TBI: Throttle Body Injection.

Table 7 Evaporative Emissions Technology Groups

Technology Group[a,b]	Vehicle(s)[c]
Post-80/Closed/Carbureted (Post-80/Cl/Carb)	2, 11*
Post-80/Closed/Fuel Injected (Post-80/Cl/FI)	1, 8*, 13a
Post-80/Open/Fuel Injected (Post-80/Op/FI)	5
Pre-80/Closed/Carbureted (Pre-80/Cl/Carb)	10*
Pre-80/Open/Carbureted (Pre-80/Op/Carb)	3*, 12

[a] The Evaporative Emissions Technology Groups are a classification based on the vehicle's Model Year, canister bottom configuration, and fuel metering system.
[b] Pre-80: MY prior to 1980 Post-80: MY post 1980 Closed: Closed bottom canister
Open: Open bottom canister.
[c] Vehicles with * were not tested on SBE.

emissions only two (1 and 13a) could be analyzed statistically by technology groups (Post-80/Cl/FI).One of the direct questions posed by the ARB for this program was: "What evaporative and exhaust effects are noted at elevated summertime temperatures typical of Southern California?". The evaporative testing portion of this program provides a good indication of the test fuels performance at an elevated test temperature (105°). However, the exhaust emission testing was performed at 75°F as was specified in the Evaporative Emission testing regulations, ARB mail-out 92-10. Thus, the scope of work only partially addresses the issue of emissions at elevated summertime temperatures.

The separate discussion of these limitations is not intended to imply that this study is not a valid one. These limitations were necessary both to conform to budgetary constraints as well as to define a practical size and scope for this study.

III. TESTING DETAILS

A. TEST EQUIPMENT AND USE

1. FTP Exhaust Emissions Tests. The exhaust emissions FTP tests were performed in a chassis dynamometer emission test cell.. A Horiba CDC 9000, 20 inch roll, 125 hp dynamometer equipped with front roll direct-drive, variable inertia range from 1000 to 6500 lbs is installed in the test cell. The driver's aid is a Horiba SADA 2040. The FTP and Running Loss driving cycles are generated by the Stand Alone Drivers Aid.

A Horiba CVS-46 Critical Flow Venturi (CFV) Constant Volume Sampler (CVS) is used to collect tailpipe exhaust samples. The CVS is modified to permit automatic purge and leak checks of each bag prior to use. Dilute sample temperatures were maintained at 110 $\pm$ 10° F during testing. The CVS is calibrated with an NIST-traceable LFE annually and as required to maintain daily propane verification tests. Separate background (dilution air) sample bags are collected for each test phase.

Zero grade nitrogen is used as the diluent for the non-dispersive infrared (NDIR) and chemiluminescent (CL) analyzers, while zero grade air is used for the flame ionization detectors (FID). ATL's master gas cylinder set is NIST traceable by the Ohio Laboratory gas supplier, AGA. The calibration cylinders and 10 point gas dividers are used to perform weekly calibration checks on each analyzer range. Working (span) gas cylinders are maintained for each range. Each bag reading is preceded and followed by a zero and range span check.

2. Running Loss Tests. The Running Loss test facility consists of an enclosed dynamometer bay with sealed vehicle entrance and personnel doors to provide access to the interior. The CVS is outside of the enclosure, with provisions to direct the vehicle exhaust through a sealed pipe in the enclosure wall. The primary source of temperature control inside the enclosure is a dual coil water-to-air heat exchanger. The water heat exchange medium enters and leaves the SHED while maintaining gas integrity. Test temperatures for Running Loss testing for this program were set at 105°F. Two road speed modulated fans provide vehicle cooling. A separate blower/heater is used to provide under-vehicle fuel tank temperature control. Vehicle combustion air is supplied from outside of the enclosure. In addition, auxiliary air for air pumps and/or pulse air systems is externally provided, preventing negative pressures in the cell and sample dilution during Running Loss tests.

The Running Loss enclosure itself is approximately 4000 cubic feet. Temperature probes are mounted at the mid-point of the long walls in accordance with 40 CFR 86.107. Air movement in the enclosure is sufficient to allow propane injections at various points in the enclosure to become completely mixed at the sample points within 60 seconds. Propane recovery/retention tests are performed in accordance with 40 CFR 86.117, with a specification of ± 2% of injected mass recovered after 10 min. Propane retention specifications are set at ± 4% at 4 hours at 75°F ambient.

A Beckman 400 FID is used to continuously monitor HC levels in the enclosure during Running Loss tests. Ranges of 100, 300, 1000, 3000, and 10,000 ppm full scale are used. Barometer, temperature and HC readings are normally recorded at the start of a run and at the end of each test phase. CO and CO_2 were continuously monitored as a safety feature to indicate the presence of any exhaust leaks into the test cell.

HC levels, ambient temperature, fuel tank liquid and vapor temperature, engine coolant temperature, and fuel tank pressure were recorded continuously during each test. In addition, three typical HC sources were automatically checked with a "Snoop" FID during the course of a test (vehicle canister, gas cap, and fuel tank drain). Three individual snoop probes were connected to an externally activated valve which allowed the instrument operator to check various evaporative emissions sources on the vehicle if HC levels started to increase during the course of a test.

3. Hot Soak Tests. The Hot Soak test took place in an evaporative emissions SHED (Sealed Housing for Evaporative Determination). The Hot Soak SHED is equipped with a mixing fan and an air-to-water heat exchanger. The water heat exchange medium is controllable to accommodate multiple test temperatures. Test temperatures for Hot Soak testing for this program were set at 105°F. The average ambient air temperature in each SHED is monitored by two thermocouple probes centrally located on the walls. Sealed purge blowers are used to reduce the HC background in the SHED to normal ambient levels between tests. The calibration of the Hot Soak SHED was performed according to the requirements contained in 40 CFR 86.117. Weekly propane recovery tests and monthly propane retention checks were also performed.

4. VT SHED Tests. ATL's Variable Temperature SHED (VT SHED) was designed and developed for the ARB's revised 72-hour diurnal evaporative emissions test procedure. Because this test procedure requires both a sealed test chamber and temperature cycling over a 40°F range, it is necessary that the sealed test chamber volume can change with the changing temperature. This is accomplished by the use of "breathing bags" located inside the VT SHED which are connected to the outside (ambient environment). As the VT SHED temperature decreases and the sealed volume correspondingly decreases, the breathing bags inflate with air from the surroundings, and *vise versa* as the temperature increases. Thus, these breathing bags are the geometric equivalent to a sealed chamber with flexible walls, thereby insuring that the pressures outside and inside the VT SHED are always nearly identical which minimizes any possible leakage into or out of the chamber. Four separate Tedlar breathing bags were used for the VT SHED; their total inflation capacity was such that a 40°F temperature decrease would inflate them to about 1/3 to 1/4 of capacity.

VT SHED temperature control was accomplished with a water-to-air heat exchanger located fully inside the enclosure. This heat exchanger was supplied from water tanks for which the temperature was programmed with time to provide an optimum off-set to the desired VT SHED temperature, thereby minimizing short-term temperature oscillations. A stainless steel bellows pump was also located inside the VT SHED to circulate sample to the FID panel for continuous HC level monitoring.

When starting a VT SHED test, the breathing bags were first filled with a measured quantity of air which was computed to provide for the 40°F diurnal range plus an additional amount sufficient to accommodate possible decreases in the barometric pressure over the 72-hour test. This inflation amount was maintained until the VT SHED was sealed at the beginning of the test, at which point the breathing bags were opened to the surrounding environment. Using the known starting inflation volume of the breathing bags and the known geometric volume of the VT SHED, the starting volume for the test could be computed.

B. STANDARD TEST METHODS

Testing for this program was conducted according to the California Air Resources Board's amended evaporative hydrocarbon test procedures identified in CARB Mail Out 92-10.

Strict adherence to this procedure was attempted with guidance from ARB dictating any deviations from the proposed test plan.

Testing was conducted by randomizing the order of test fuels. Each vehicle completed it's test fuel matrix prior to the next vehicle entering the program. A copy of the test flow schedule is included as Appendix D and should be used in conjunction with the following test sequence descriptions.

1. Determination of Canister Capacity. All canister capacity determination steps were performed with the canister removed from the vehicle but maintained in a physical orientation that was identical to that when installed in the vehicle. The canister capacity is defined as the grams of commercial grade butane that have been absorbed by the canister at the point that 2.0 grams of butane have broken through. For this determination, the butane is presented to the canister as a mixture of 1:1 (v:v), butane:zero nitrogen flowing into the canister's fuel tank connection at a rate of 15 ± 2 grams of butane per hour. All canister connections other than the tank connection and the vent to the atmosphere are blocked for the capacity determination. Prior to beginning the capacity determination, the canister is purged with 300 bed volumes (as determined geometrically from the canister external dimensions) at 48 scfh of ambient air which is controlled to an absolute humidity of 75 ± 10 grains of water per pound of dry air. The canister is then weighed and the purge is repeated until the weight loss per purge step is less than 2.0 grams. The canister is then loaded with butane as described above and the butane escaping out the vent to the atmosphere is piped to a backup canister on a laboratory balance. The backup canister is purged thoroughly prior to use to insure that it will undergo no purge-down losses while the capacity determination is in progress. Open bottom canisters are fitted with a Tedlar® scavenging mask of minimal dead volume for collecting the breakthrough butane. When the backup canister has gained 2.0 grams of breakthrough butane, the loading is stopped and the canister is weighed to determine the net weight increase which is defined as the canister capacity. This capacity determination was performed until a consensus value within ±10% was obtained. The canister capacities of each test vehicle are included as Table 8.

2. Vehicle Preconditioning. For vehicles identified as adaptive learning vehicles, an additional pre-preconditioning was performed (Appendix E). All vehicles began the test sequence with a fuel drain and fill to 40% tank capacity, a cold soak period (12 -36 hours at 75°F) for vehicle stabilization followed by a single UDDS cycle. After the UDDS

Table 8 Test Vehicle Canister Capacities

Veh. No.	Year, Make, Model	Canister Capacity[a], grams butane	Open or Closed Bottom
1	'90 Oldsmobile Calais	29.2	Closed
2	'85 Chevrolet Blazer/S10	23.5	Closed
3	'73 Oldsmobile Cutlass	28.2	Open
5	'90 Honda Accord	35.4	Open[b]
7	'83 Plymouth Reliant	17.9	Closed
8	'87 Ford Escort	19.5 (original)[c] 21.6 (replacement)	Closed
9	'86 Chevrolet Cavalier	34.9	Open
10	'76 Ford Granada	14.3	Closed
11	'84 Chrysler New Yorker	42.5	Closed
12	'78 Toyota Celica	11.5	Open[b]
13a	'89 Ford Taurus	50 (Ford Spec.)	Closed

(a) All available replicates are shown. Capacity determined using the ARB 92-10 procedure which is defined as the amount of butane adsorbed by the canister at the point when 2.0 grams of butane have broken through the canister. Prior to capacity determination, the canister was purged using the 92-10 humidity, flow rate, and total purge volume specification until a constant purged-down weight was observed (typically 2 or 3 times).

(b) The "open bottom" of the Accord and Celica canisters are not open in the same sense that the early GM canisters had open bottoms. Both the Accord and Celica canister are "open bottom" by virtue of the vent connection hose bib (about 3/8" and 1/4" inside dia. tubes, respectively) being located on the bottom of the canister. The GM open bottom design is a 2-inch to 3-inch diameter opening in the bottom which functions as the vent. Just inside this bottom vent opening is the screen which retains the carbon granules inside the canister.

(c) The original canister for this vehicle was irreparably damaged, and was replaced with one from a salvaged vehicle of identical specification and similar miles.

cycle, the fuel was drained and replaced with a fresh 40% fill, and the vehicle was put again into a cold (75°F) soak for 12 - 36 hours.

3. *Canister Preconditioning.* All canister preconditioning steps were performed with the canister removed from the vehicle but maintained in a physical orientation that was identical to that when installed in the vehicle. All canister preparation activities were documented on the Canister Preparation Form (Appendix F). The canister was removed from the vehicle after the first UDDS driving cycle in the prep procedure. It was purged once with 300 bed volumes of humidity-controlled ambient air. As agreed upon with the

ARB, the humidity control was changed from the 92-10 requirement of 75±10 grain/lb to the 93-46 specification of 50±10 grains/lb. The weight of the purged down canister was recorded and then the canister was loaded with butane:nitrogen, 1:1 (v:v) (exactly as described for the canister capacity determination) until a butane amount equal to 150% of the determined capacity has passed into the canister. During this step, all canister connections were blocked except the tank connection (attached to the butane supply) and the vent to atmosphere. The butane and nitrogen flow rates were verified immediately prior to and immediately following the loading step at 104 ± 7 mL/min (referenced to a pressure of 29.9 inches of mercury and 68°F). For butane, this flow rate corresponded to 15.0 g/hr. At the completion of the loading time, the canister was re-weighed to determine the net weight increase from the butane loading procedure. The canister was then immediately reinstalled in the vehicle.

4. FTP and Fuel Temperature Stabilization. Upon completion of the soak period, a cold start exhaust test was performed according to specifications in 40 CFR 86.135. Exhaust emission testing (HC, CO, CO_2, NO_X, and CH_4) was conducted on all prescribed fuels and vehicles. All vehicles on all fuels received HC and aldehyde speciation on each of the three test sample Bags and one of the dilution air (background) sample Bags (second Bag). Tests which were performed on the SBE fuel received additional alcohol speciation. The exhaust emission test was followed by a one to four hour stabilization period in preparation for the Running Loss test. During the first hour, the fuel temperature was allowed to stabilize at 105°F. If at the end of the first hour the fuel was still not at a stabilized 105°F, artificial heat was applied to complete the stabilization within the four hour time window.

5. Running Loss. After the liquid fuel and Running Loss enclosure ambient temperatures were stabilized at 105°F, the Running Loss test could begin. The Running Loss test consisted of three UDDS driving cycles (performed at an ambient temperature of 105°F), each followed by a 120 second idle period, during which the engine remained running. Hydrocarbon speciation samples were taken prior to the start of the Running Loss test and again during the final 120 second idle period. Vehicles which were tested on the SBE fuel received additional alcohol speciation at the same time. The fuel tank liquid temperature, in accordance with the applicable procedures in ARB Mail-out 92-10 was controlled during dynamometer operation within ± 3°F from the liquid fuel temperature profile obtained on the road. After the final 120 second idle period, which follows the third

UDDS cycle, the vehicle was placed into a standard SHED at 105°F for a one hour Hot Soak test.

6. *Hot Soak.* Immediately following the completion of the Running Loss test the vehicle was placed into a standard SHED for the Hot Soak test. The one hour Hot Soak test was performed at 105°F. Initial HC and speciation (when applicable) samples were taken immediately prior to the vehicle entering the SHED.

7. *Evaporative Emissions.* The final step in the test procedure was the 72 hour diurnal test. Following the completion of the Hot Soak test the vehicle was placed in soak at 65°F for 6 to 36 hours (this altered soak time prior to the VT SHED portion of the test was performed with the consent of the ARB). The tank fuel temperature was allowed to cool to a stable 65°F prior to being placed in the VT SHED to begin the first of three 24 hour ambient temperature cycles. Ambient temperature range for each cycle is 65 - 105 - 65°F. The duration of each real time heating period (65 - 105°F) is eleven hours, followed by a thirteen hour cooling period (105 - 65°F). This test was performed in ATL's VT SHED. Hydrocarbon concentrations were traced continuously in the VT SHED and the samples were reported for presentation as 24 hour maximums.

VT SHED enclosure hydrocarbon speciation samples were taken on all fuels with six of the test vehicles (Table 1). Alcohol speciation was taken during all the tests which were performed with the Splash Blended Ethanol fuel. The speciation samples were collected at the start and end of each heating and cooling period. In addition, some vehicles were speciated every three hours (Table 9). These samples were analyzed for hydrocarbons (C_1-C_{12}), ethers, and impinged alcohols (SBE only).

Table 9 Additional Test Speciation Matrix

Vehicle	Fuel	Additional Speciation
2	Phase 2	Additional HC speciation every three hours during VT SHED test
5	Phase 2	Additional HC speciation every three hours during VT SHED test
5	SBE	Additional alcohol speciation every three hours during VT SHED test
9	Phase 2	Additional HC speciation every three hours during VT SHED test
13	Phase 2	Additional HC speciation every three hours during VT SHED test
13	SBE	Additional alcohol speciation every three hours during VT SHED test

C. CHEMICAL SPECIATION PROCEDURES

1. Hydrocarbon Analysis. Three identically equipped Varian 3600 gas chromatographs, GCs, were used for HC speciation. Each GC was equipped with two temperature-controlled Valco valve injectors; two DB-1, 60 meter x 0.32mm ID, 1 μm film, capillary columns (J&W #123-1063), and two flame ionization detectors, FIDs.

Emission samples and background samples were collected in 50- to 100-liter Tedlar® bags. For the FTP exhaust emission test, the three sample Bags (Bags 1, 2 and 3) plus one background Bag (taken during FTP Bag 2) were analyzed. For the Running Loss test, two bags were analyzed: an initial background Bag sampled just prior to key-on after the enclosure was sealed and a sample bag taken at the end of the final two-minute idle. The Hot Soak sample and background Bags were analogously taken. For the extended diurnal, seven bags were analyzed: an initial background bag taken just after SHED sealing plus a 105°F/65°F pair for each of the three 24-hr periods of the test (i.e., sampled at hour 11, 35 and 59 for the 105°F bags and at hour 24, 36 and 72 for the 65°F bags). For 6 of the vehicle/fuel combinations, HC speciation of the extended diurnal was performed every 3 hours plus the 105°F points (hours 11, 35 and 59).

Exhaust emission bag samples were expeditiously analyzed to minimize chemical degradation of sensitive species such as 1,3-butadiene. Typically, FTP Bags 1 and 2 were simultaneously injected on one of the dual column GCs within 20 to 45 minutes of the end of FTP Phase 2. The corresponding Phase 3 Bag and Background Bag time delay to analysis was typically less than 60 to 90 minutes. The gas samples were transferred to the GC injector valve using a stainless steel and Teflon® bellows pump, providing sample to the injector valve at a controlled pressure. Data processing was facilitated with a Varian Star chromatography data system with final data processing on PC.

GC analysis conditions enabled analysis over the volatility range from methane to dodecane and are summarized as follows:

Parameter			Value
Sample Size, µL, operated at 17 psi			100
Injection Split Ratio			none (splitless)
Injector Temp., °C			150
Detector Temp., °C			250
Helium Carrier Pressure, psi (giving 23 cm/sec @ 140°C)			~17
Oven Program			
Step	Rate, °C/min	Temp. Final,°C	Hold Time, min.
1	--	-38	3.5
2	15	0.0	0.0
3	10	50	0.0
4	3.7	172	0.0
5	25	220	0.0

Each day, a 23-component calibration standard (CRC-4, Scott Specialty Gases, Troy, Michigan) containing HCs in the range from C_1 to C_{13} at 3 to 9 ppmC was analyzed to update the calibration factors and provide chromatographic quality control.

2. *Carbonyl Analysis.* Carbonyls (aldehydes and ketones) were collected from the CVS diluted exhaust gas using liquid impingers and a diluted exhaust gas flow rate of about 3.5 liters per minute. Four samples were analyzed: the three Bags of the FTP plus a single, averaged background, sampled over all three Bags. Two impingers, connected in series and each containing 25 mL of carbonyl trapping solution, were held at 0°C in an ice bath during sampling. The impinger fluid was a solution of 2,4-dinitrophenylhydrazine (2,4-DNPH) in acetonitrile (0.25 mg/mL) with two drops of 1N perchloric acid added to catalyze the formation of the 2,4-DNPH carbonyl derivatives.

High pressure liquid chromatographic (HPLC) analysis of the carbonyls was performed on a Spectra Physics SP8800 HPLC equipped with a ternary gradient system, Varian SP4400 data integrator and a Spectra Physics SP8875 auto sampler with a 10 µL loop. The HPLC column was an ODS 4.6mm x 22cm, 5µm column (Rainin #ODS-224) with a solvent flow of 1.0 ml/min at ambient temperature. The DNPH derivatives were detected at 360nm using a Spectra Physics SP200 variable wavelength detector. The gradient elution conditions were the following:

	Volume Percent			
Step	Mix 1(a)	Mix 2(b)	Methanol	Time
Initial	50	50	0	3.0 min hold
Gradient #1	25	40	35	in 4.0 min.
Gradient #2	0	5	95	in 2.0 min.
Return to Initial	50	50	0	in 3.0 min.
Equilibrate Initial	50	50	0	3.0 min. hold

(a) Water:methanol, 60:40, v:v.

(b) Acetonitrile:methylene chloride, 90:10, v:v.

The fluid samples from the two impingers in series were analyzed separately by HPLC and the results combined for each test phase. A calibration standard containing DNPH derivatives of nine carbonyls was analyzed immediately before and after the samples from each test set, and average calibration response factors from them were used to quantify the test data. The nine quantified carbonyls are:

Formaldehyde	Acetone	Methyl ethyl ketone
Acetaldehyde	Propionaldehyde	Benzaldehyde
Acrolein	Crotonaldehyde	Tolualdehyde (3 isomers summed)

3. Alcohol Analysis. Whenever the Splash Blended Ethanol fuel was tested, alcohol samples for ethanol determination were generated from diluted exhaust gases using an impinging approach identical to the one for carbonyls, described above, except that the impinger fluid was reagent water. SHED samples were similarly prepared by impinging sample from the same bag used to sample the SHEDs for HCs, described above. After sampling but prior to analysis, the impinger fluid was spiked with a quantification internal standard, n-propanol. Again, the fluid samples from the two series impingers were analyzed separately and the results summed for the test samples.

Alcohol samples were analyzed for ethanol by GC using a cold, on-column injection of the aqueous impinger fluid. The GC was a Varian 3600 equipped with a Varian 8035 auto sampler, an FID detector and a DB-1, 30 meter x 0.53 mm ID, 5 μm film, capillary column (J&W #125-1035). A 1.5 to 3.0 meter x 0.53 mm ID deactivated fused silica retention gap was used at the column inlet. The analysis conditions were the following:

Parameter	Value
Injector Temperature, °C	70
Detector Temperature, °C	250
Injection Volume, µL	1.2
Helium Carrier, mL/min. (flow controlled)	3 to 5
Initial Oven Temperature, °C	90
Initial Hold Time, min.	3.0
Final Oven Temperature, °C	120
Rate, °C/min	20
Final Hold Time, min	0.0

The alcohol chromatographic data are quantified by the internal standard method using response factors from the analysis of calibration standards which are analyzed with each test set.

4. *Speciation Data Processing.* All of the speciation data was reduced in a similar fashion. The raw chromatograms and raw peak detection reports were generated by an instrument-specific data system or integrator. Carbonyl and alcohol chromatographic data were manually processed into the PC-based templates for final result calculations. HC data text files of the peak detection results were transmitted to a host computer where relative retention-based peak matching software was applied for initial peak identification. Data clerks inspected these peak assignments in every chromatogram for correct HC species identification and quantitation. Peak height was used for hydrocarbon and carbonyl quantitation and peak area was used for alcohol quantitation. The chromatographic results after final QA inspection were electronically copied to a calculating template, put in spreadsheet form, and the final results prepared in hard copy and electronic format.

IV. DATA ANALYSIS APPROACH

At the request of the ARB, a univariate approach was taken to evaluate the effects of fuels and vehicle technology effects on evaporative and exhaust emissions. This was done through the repeated application of the paired-t test on individual fuel differences. Appendix G contains a complete description of the paired-t test.

The paired-t test was employed for the statistical analysis for a variety of reasons. The analysis was done on an individual vehicle basis as was requested by the Air Resources Board. The comparisons were specific to a base fuel and not all the comparisons were of interest (the Base fuel to Phase 1 fuel comparisons were of limited value in relation to the Phase 2 fuel to SBE fuel comparisons). This type of analysis was better suited by the use of the paired-t test rather than the use of a multi-comparison type of test. Additionally, the paired-t test takes into account the correlation between tests on the same vehicle while also providing a greater degree of statistical power than a multi-comparison type of analysis.

The FTP exhaust emissions analyzed consisted of the following eight emissions:

1. Mass emissions (g/mile): HC, CO, CO_2, and NO_X.
2. Toxic species (mg/mile): formaldehyde, acetaldehyde, 1,3-butadiene, and benzene.

Exhaust emissions data for other hydrocarbons, carbonyl compounds, and alcohols were not analyzed as individual species. Exhaust emissions were collected for FTP Bags 1-3. The analysis of each exhaust emission was done for the composite emissions (a weighted combination of the three test segments) as well as the individual Bags.

Evaporative emissions analyzed consisted of the following nine emissions:

1. HC: Running Loss (g/mile) by phase (3) and total, Hot Soak (g/test), VT SHED (g/day) (3).
2. Benzene: Running Loss benzene emissions (mg/mile) by total.

At the request of ARB, all paired-t tests were computed using the natural log of the ratio between two fuels, rather than the simple difference in emissions between fuels. This transformation to logarithms has the advantage of improving the accuracy of the estimated statistical significance (p-values) since the logarithm of emissions appears more normally distributed. In addition, it simplifies the reporting of the results by allowing differences in emissions effect to be reported as ratios, or percentages, rather than the measured units, grams, g/mile or mg/mile. The results of these analyses are summarized in various tables which are included as Appendix H.

Statistical significance levels (p-values) were calculated for the two-sided test of whether the logarithm of the ratio of emissions from two fuels is zero or not. This is equivalent to testing whether the ratio is equal to 1.0, or, equivalently, whether the emissions from the two fuels are equal. At the request of the ARB, the associated p-values for these tests are reported for levels of 0.1 and below in Appendix H. A p-value is a measure of the probability of whether an observed difference in emissions is real or whether it could have occurred by chance. However, since the paired-t tests were not conducted using an experiment-wise type-1 error rate, the reader is cautioned to expect a small portion of the indications of statistical significance to be false. The experiment-wise type-1 error rate is an indication of the probability that one or more tests is falsely significant. The type-1 error rate is very high in this instance (i.e., false reports of significant effects are more likely) due to the use of a univariate rather than multivariate approach. Hence in interpreting the findings of this study, it is as important to look for consistent patterns of differences as it is to examine the calculated significance levels of individual differences.

Additionally, the ARB requested the grouping of vehicles into technology classes. These groupings, shown in Tables 6 and 7, were different for exhaust and evaporative emissions, and included from one to four vehicles in each individual technology group. The technology groups were defined by the ARB in an effort to relate the resulting data to the ARB predictive model. For exhaust emissions, the groups represent the four combinations of catalyst types and fuel metering systems represented in this particular vehicle fleet. When a technology group contained only a single vehicle, a paired-t test could not be conducted. Since the other groups consisted of only two to four vehicles, the statistical power associated with their paired-t tests is very low. Hence, the absence of statistical significance between fuels within a technology group should not be interpreted as an indication that there is no difference between those fuels within that technology group.

It should also be noted that only nine of the eleven test vehicles were used to evaluate evaporative emissions. The evaporative test data from the two omitted vehicles did not present the expected pattern of higher emissions from higher volatility (RVP) fuels. Test documentation was investigated for possible procedural errors; however, no errors were detected. After reviewing all of the data the ARB decided, based upon engineering judgment, to exclude test results from vehicles 7 and 9 from the analysis of evaporative effects. All eleven test vehicles were used in the analysis of exhaust emissions.

V. RESULTS AND DISCUSSION

The discussion of results is divided into four separate sections: fuel effects on exhaust emissions, fuel effects on exhaust emissions by vehicle technology, fuel effects on evaporative emissions, and fuel effects on evaporative emissions by vehicle technology. For clarity and brevity, the discussion of test results will concentrate on statistically significant fuel and technology related effects. It is important to note that even though there are emissions reductions in some cases when comparing test fuels, only differences which have been determined to be statistically significant at the 95% or higher confidence level will be focused on in this section. Many of the effects found to be significant at the 90% level may be due to random chance (a type-1 error, as discussed above) and therefore are not highlighted here but are reported in Appendix H. All mass emissions data is included as Appendix I.

A. FUEL EFFECTS ON EXHAUST EMISSIONS

Paired-t tests (Appendix G contains an explanation of the paired-t test) were employed to investigate fuel effects independent of vehicle technology. The majority of fuel effects for exhaust emissions were found to involve Phase 2 and a smaller number of effects were found for SBE. Therefore, the discussion of results will center on the positive and negative effects found for Phase 2 and SBE as they are compared to Base, Phase 1, and each other. There were no significant fuel effects found for exhaust emissions when Base was compared to Phase 1.

Tables 10 and 11 summarize the fuel effects for Phase 2 (when compared to Base, Phase 1, and SBE) and SBE (when compared to Base and Phase 1). Any positive or negative effects are reported in terms of the percent increase or decrease in emissions for the fuel comparison. Values which were determined to be significant at the 95% or higher level are in bold. The tables are divided into four sections: the three individual bags of the FTP exhaust emission test and the weighted composite FTP result.

1. Exhaust HC. There were few statistically significant fuel effects found concerning exhaust HC, although the trend was consistent towards lower exhaust hydrocarbon production with the use of Phase 2 fuel. Phase 2 produced lower HC emissions than SBE in bags 1 and 3 of the FTP. Phase 2 also produced lower HC emissions than both Base and Phase 1, but only in the third bag of the FTP.

Table 10 - Phase 2 Effects for Exhaust Emissions - % Change in Emissions (g/mile)

	FTP Bag 1			FTP Bag 2			FTP Bag 3			FTP Composite		
	Ph 2/ Base	Ph 2/ Ph 1	Ph 2/ SBE	Ph 2/ Base	Ph 2/ Ph 1	Ph 2/ SBE	Ph 2/ Base	Ph 2/ Ph 1	Ph 2/ SBE	Ph 2/ Base	Ph 2/ Ph 1	Ph 2/ SBE
HC	-4	-3	**-9**	-8	-7	-7	**-16**	**-15**	**-17**	-9	-7	-12
CO	-4	-4	+8	-33	-29	-33	**-32**	**-29**	**-22**	-15	-14	-11
CO_2	-20	-8	+6	**-1**	**-2**	+7	-1	-1	+7	-1	**-1**	+7
NO_X	**-9**	**-9**	**-9**	-4	**-10**	-8	-11	-8	-10	**-7**	**-8**	-9
benzene	**-33**	**-36**	**-19**	-25	**-26**	+21	**-45**	**-45**	**-33**	**-36**	**-36**	**-21**
1,3-butadiene	**-21**	**-22**	**-15**	-16	-20	-29	**-22**	**-25**	-19	**-24**	**-24**	-15
formaldehyde	**+32**	**+29**	+17	**+27**	+33	-13	**+29**	**+16**	+6	**+31**	**+26**	+7
acetaldehyde	+1	0	**-49**	-19	-13	-23	-10	**-22**	**-45**	-5	-8	**-52**

Enlarged and bold face type indicates significance at the 95% or higher level.
The SBE fuel was <u>not</u> tested in vehicles 3,7,8,10, and 11. All comparisons involving the SBE fuel only consider data for vehicles 1,2,5,9,12 ,and 13.

Table 11 - SBE Effects for Exhaust Emissions- % Change in Emissions (g/mile)

	FTP Bag 1		FTP Bag 2		FTP Bag 3		FTP Composite	
	SBE/Base	SBE/Ph 1	SBE/Base	SBE/Ph 1	SBE/Base	SBE/Ph 1	SBE/Base	SBE/Ph 1
HC	-1	-6	0	+1	-7	-3	-4	-3
CO	-18	-25	-17	-8	-18	-16	-11	**-15**
CO_2	-6	-5	-8	-8	-7	-7	-8	-7
NO_X	-3	-1	+2	-5	-7	2	-1	-1
benzene	**-27**	**-27**	-31	-27	**-30**	**-26**	**-27**	**-25**
1,3-butadiene	**-16**	-13	-1	-2	-7	+0	-18	-15
formaldehyde	+5	+13	+30	+13	+7	+11	+11	+14
acetaldehyde	**+79**	**+88**	+16	+20	+31	+26	**+73**	**+77**

Enlarged and bold face type indicates significance at the 95% or higher level.
The SBE fuel was <u>not</u> tested in vehicles 3,7,8,10, and 11. All comparisons involving the SBE fuel only consider data for vehicles 1,2,5,9,12 ,and 13.

Previous studies have indicated that a reduction in fuel sulfur level results in a corresponding reduction in HC, CO, and NO_X emissions due to increased vehicle catalyst activity (conversion efficiency).[9] The Phase 2 and SBE fuels in this study have sulfur levels of 36 and 37 ppm respectively (Appendix C). This is a greater than fourfold reduction in fuel sulfur levels when compared to Base (134 ppm) and Phase 1 (138 ppm). The reduced sulfur level of Phase 2 and SBE may account for the increased conversion (more efficient catalyst operation is expected with the use of a lower sulfur content fuel) of hydrocarbons in these tests. *In general, Phase 2 produced lower exhaust HC emissions than the other fuels for this vehicle fleet.*

2. Exhaust CO. Most of the fuel effects found for exhaust CO were not statistically significant, except in Bag 3 of the FTP. Phase 2 produced lower CO emissions than Base, Phase 1 and SBE. Referring to the associated p-values in Appendix H, it appears likely that the effects versus Base and Phase 1 are real due to their high level of statistical significance (95% and 99% respectively). SBE produced lower CO emissions than Base and Phase 1 across the entire FTP, although the effect was significant only versus Phase 1 in the FTP composite.

Both the well-documented[6,7,8] effect of oxygenates in fuel, which results in a decrease in CO exhaust emissions (for some vehicle technologies), and the catalyst deactivation effect of higher sulfur in the Base and Phase 1 fuels may account for the trend towards lower CO with the use of Phase 2 and SBE in this test fleet. *Phase 2 produced lower CO emissions than the other fuels, showing a statistically significant reduction during the third bag of the FTP tests for this vehicle fleet. SBE also showed a trend towards reduced CO exhaust emissions when compared to Base and Phase 1 for this vehicle fleet.*

3. Exhaust NO_X. Statistically significant fuel effects on exhaust NO_X emissions were concentrated in the first bag of the FTP, where Phase 2 was better than each of the other test fuels, including SBE, in terms of NO_X emissions. The trend towards lower NO_X emissions for Phase 2 <u>and</u> SBE (compared to Base and Phase 1) was evident in almost all of the phases of the FTP. Related work indicates that the presence of ethanol or MTBE in fuel may increase the level of NO_X exhaust emissions.[8] Further, it has been indicated in

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[9] Jack D. Benson, et al., "Effects of Gasoline Sulfur Level on Mass Exhaust Emissions - Auto/Oil Air Quality Improvement Research Program", SAE Paper #912323

EPA models[10] that the addition of oxygenate would cause slight to significant increases in NOx, depending upon vehicle technology. However, ATL's previous work with the same vehicle fleet as was used in the current work indicated that the presence of oxygenates produced variable (both positive and negative) changes in NO_X emissions rates.[11] Those changes were sometimes considerable in magnitude but usually not statistically significant. However, California ARB staff believe that limiting the oxygen in gasoline to 2.2% will avoid the increases in NO_X that will occur at higher oxygen levels.[7] In this study, oxygen content was limited to 2%, thus, the differences in fuel sulfur level and other fuel properties may account for the differences in exhaust NO_X emissions. Reducing the sulfur content of a fuel has been shown in other work[12] to improve catalyst activity in reducing exhaust NOx emissions. *Phase 2 produced statistically significantly lower NO_X emissions than Base or Phase 1 during the first bag and FTP composite for this vehicle fleet. Additionally, Phase 2 produced statistically significantly lower NO_X emissions than SBE for the first bag of FTP tests for the SBE vehicle fleet.*

4. ***Exhaust CO_2.*** Statistically significant fuel effects on exhaust CO_2 emissions were of such a low level of significance and were so widely dispersed across the test fuel comparison matrix that the results can most likely be attributed to random chance rather than any fuel effect. The measured energy content (see Appendix C) of Phase 2 and SBE were, as expected, lower than those measured for the hydrocarbon-only fuels (Base and Phase 1). Normally, one would therefore expect this to result in lower fuel economy (as calculated by the "Carbon-balance" method which correlates inversely with CO_2 content of the exhaust). Since CO_2 emissions were so variable, the expected impact of oxygenate dilution on fuel economy could not be documented in this program. *None of the test fuels produced statistically significantly more or less CO_2 emissions during the FTP tests for this vehicle fleet.*

5. ***Exhaust Benzene.*** As expected, Phase 2 and SBE produced statistically significantly lower benzene emissions than Base or Phase 1, since Phase 2 and SBE contained one third

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[10] "Guidance on Estimating Motor vehicle Emission Reductions from the Use of Alternative Fuels and Fuel Blends", U.S. Environmental Protection Agency, Technical Report EPA-AA-TSS-PA-87-4, Ann Arbor, MI, July 21, 1988.
[11] Samuel V. Lucas, et al., "Effect of Use of Low Oxygenate Gasoline Blends upon Emissions from California Vehicles", Report presented to the California Air Resources Board and the South Coast Air Quality Management District February 25, 1994.
[12] Jack Benson, et. al., "Effects of Gasoline Sulfur Level on Exhaust Mass Emissions" , SAE Paper #912323.

less benzene by volume and, on average, 6.0% less total aromatics by volume than either Base or Phase 1.

Benzene is the lowest carbon number aromatic hydrocarbon (C_6H_6). The presence of benzene in exhaust emissions is due to both its fuel content and formation as a partial combustion product of heavier aromatic fuel components. Exhaust emissions of benzene were reduced an average of 31% for the Phase 2 and SBE fuels when compared to the Base and Phase 1 fuels. Surprisingly, there was also a 26% reduction in exhaust benzene when Phase 2 was compared to SBE. This difference can not be explained by fuel composition differences since the fuels aromatic content (27 and 26 vol%) and T_{90} distillation values (291 and 295°F) were very similar. *Both Phase 2 and SBE produced statistically significantly lower benzene emissions than Base or Phase 1 during the FTP tests for this vehicle fleet. However, Phase 2 also produced statistically significantly lower benzene emissions than SBE, for the SBE vehicle fleet.*

*6. **Exhaust 1,3-Butadiene.*** The fuel effects on 1,3-butadiene emissions were concentrated in the first and third bags of the FTP, and the corresponding effects on the FTP composite results. The absence of statistical significance for Bag 2 is at least partially due to the fact that vehicles with low HC emission often do not emit detectable levels of 1,3-butadiene in Bag 2. In general, Phase 2 produced statistically significantly lower 1,3-butadiene emissions than each of the other test fuels. However, in terms of the level of statistical significance, the Phase 2/Base and Phase 2/Phase 1 comparisons were stronger than the Phase 2/SBE comparison.

1,3-Butadiene is a straight chain di-olefinic hydrocarbon (C_4H_6) which is absent in fuel and present in exhaust as a combustion by-product. Previously published work has indicated that the reduction of olefins and the T_{90} distillation point have resulted in reduced levels of 1,3-butadiene in vehicle exhaust emissions[13], and the present data are in agreement with these conclusions. Specifically, SBE which has a reduced level of olefins and a lower T_{90} point (5.6% vol. and 296°F) than both Base (9.4% vol. and 312°F) and Phase 1 (8.5% vol. and 313°F) produced lower levels of 1,3-butadiene emissions. SBE provided composite FTP exhaust emissions reduction of 18.3% and 15.3% compared to Base and Phase 1 respectively. Phase 2 has very similar physical properties to SBE (6.1%

[13] Robert A. Gorse, et al., "Toxic Air Pollutant Vehicle Exhaust Emissions with Reformulated Gasolines", SAE Paper #912324

vol. olefins and a 290°F T_{90} point). However, the 1,3-butadiene emission reduction with the Phase 2 fuel was much greater than with SBE. The addition of MTBE to the test fuel produced statistically significant reduction not only when compared to the Base and Phase 1 fuels but also when compared to SBE (24.8%, 24.6%, and 26.6% respectively). *Phase 2 produced statistically significantly lower 1,3-butadiene emissions than Base or Phase 1 during the FTP tests for this vehicle fleet. Additionally, Phase 2 produced statistically significantly lower 1,3-butadiene emissions than SBE during Bag 1 of the FTP tests for the SBE vehicle fleet.*

7. ***Exhaust Formaldehyde.*** Formaldehyde is a product of the incomplete combustion of several fuel components and does not occur as fuel component. As indicated in Appendix B, Phase 2 uses 10.7 vol% MTBE as an oxygenate. It was expected that formaldehyde emissions would increase with the use of MTBE since formaldehyde is a thermal breakdown product of MTBE. The California ARB has taken this increase into account in their analysis of the "Total Effect of Phase 2 Specifications"[7]:

Table 12 Emissions Changes in 2000 Due to Phase 2 Specifications (tons/day)

Benzene	-18.8
1,3-butadiene	-1.6
Formaldehyde	+6.0
Acetaldehyde	+0.2

Phase 2 did in fact produce more exhaust formaldehyde than either Base (32%) or Phase 1 (26%) for FTP composite results. However, formaldehyde exhaust emissions were even higher for SBE (6.2%) than for Phase 2 in the FTP composite although this result was not statistically significant. This increase relative to Phase 2 is not completely unexpected because formaldehyde is a thermal breakdown product of ethanol also, and its formation from ethanol during combustion may have fewer or less competitive alternative (i.e., non-formaldehyde producing) pathways versus MTBE. A trend was shown to be consistently positive (although not significantly so) for the production of formaldehyde from the use of SBE relative to the other fuels. *Phase 2 produced statistically significantly higher formaldehyde emissions than the Base or Phase 1.*

8. Exhaust Acetaldehyde. SBE produced statistically significantly more acetaldehyde emissions than Base, Phase 1, or Phase 2 in bag 1 and the FTP composite. SBE uses 5.6 vol% ethanol as an oxygenate. Like formaldehyde, acetaldehyde is present only as a product of incomplete combustion and is not a part of gasoline. It was fully expected that the ethanol in SBE would produce an increase in exhaust acetaldehyde emissions because it is a partial oxidation product of ethanol. SBE did produce statistically significant levels of acetaldehyde when compared to the other test fuels. The acetaldehyde exhaust emissions increase was 73% when compared to Base, 78% when compared to Phase 1, and 110% when compared to the Phase 2. *SBE produced statistically significantly higher acetaldehyde emissions than the Base, Phase 1, or Phase 2 fuels for this vehicle fleet.*

B. FUEL EFFECTS ON EXHAUST EMISSIONS BY VEHICLE TECHNOLOGY

Paired-t tests were employed in an effort to investigate fuel effects on exhaust emissions within vehicle technology groups (Table 6). Note that the number of vehicles in each technology group is very small, varying from one to four. Therefore, the statistical power associated with the paired-t tests for evaluating fuel effects by technology is very low (i.e. an effect may have to be very large to be detected at the 95% level of significance). For the technology group represented by only a single vehicle, a test result ratio (the effect of one fuel compared to the effect of another) is reported, as a paired-t test could not be performed. It should also be noted that a paired-t test result could not be reported for two technology groups for SBE tests since only one or none of the vehicles in that technology group was tested on SBE (Oxy Cat/Carb (1) and No Cat/Carb (0)). Also note that the percent changes in Tables 13 - 20 for the technology class No Catalyst/Carbureted were not subjected to a paired-t test, since only one vehicle existed for this class, thus a determination of statistical significance was not possible.

1. Exhaust HC by Vehicle Technology. As shown in Table 13, Phase 2 produced some statistically significant reductions compared to Base and Phase 1 in bag 3 of the FTP with the TWC/Carb or TBI technology group. This reduction compared to Base carried over into the FTP composite. The TWC/FI technology class responded with a reduction in exhaust HC for Phase 2 compared to SBE. The only other statistically significant results of the comparison of fuel within a vehicle technology group for exhaust HC was a statistically significant decrease for Phase 2/SBE in the TWC/FI technology group and an unexpected increase for Phase 2 versus Phase 1 in the Oxy cat/Carb technology class. *The* *few vehicle technology/fuel type changes in exhaust HC levels involved mainly reductions due to the use of Phase 2.*

2. ***Exhaust CO and CO_2 by Vehicle Technology.*** Tables 14 and 15 show that the number of statistically significant comparisons for these technology groups is consistent with random statistical variation. *None of the technology groups stood out as being statistically significantly more responsive to fuel effects than another for CO or CO_2 emissions.*

3. ***Exhaust NO_x by Vehicle Technology.*** There were a small number of statistically significant fuel effects, as shown in Table 16, all related to the TWC technology groups. This result may reinforce the relationship between fuel sulfur and the effectiveness of a three-way catalyst in reducing NO_x because the effects of the low sulfur fuels were only statistically significant for the TWC technology groups. In bag 1, Phase 2 produced a reduction in exhaust NO_x when compared to Phase 1 (and SBE) with TWC/FI technology. Phase 2 reduced exhaust NOx in Bag 2 for TWC/Carb or TBI (compared to Base) and in TWC/FI vehicles (compared to Phase 1). Phase 2 showed a trend towards reduction versus Base and SBE in all technologies, in almost all bags and the FTP composite, but these results were not statistically significant. The behavior of Phase 2 versus Phase 1 was mixed across technologies (insignificant increases with Oxy Catalyst/Carbureted, insignificant decreases for all others) and phases of the FTP, as was the comparison of SBE to both Base and Phase 1. The only statistically significant response noted for SBE were reductions in NO_x in comparison to Base for the TWC/Carb or TBI technology class, in Bag 2 and the FTP composite. *The TWC/FI technology group showed a statistically significant reduction in NO_x emissions for Phase 2 when compared to Phase 1 in both bags 1 and 2. Additionally, the TWC/Carb or TBI technology group had a strong statistically significant reduction in NO_x emissions when Phase 2 or SBE was compared to Base.*

4. ***Exhaust Benzene by Vehicle Technology.*** There were multiple statistically significant fuel effects which were determined to be related to technology groups, as shown in Table 17 Phase 2 produced reductions in exhaust benzene in all bags, in all vehicle technologies, compared to Base and Phase 1. Many of these reductions were statistically significant. Phase 2 also reduced benzene emissions compared to SBE in bag 1 in TWC/FI and bag 3 in TWC/Carb or TBI. SBE showed reductions compared to Base and Phase 1 in almost all cases as well, but there were statistically significant effects only in TWC-equipped

Table 13 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in HC Emissions (g/mile)

FTP Bag & Technology Group	Phase2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	+10	+8	--	--	--
Oxy Catalyst/Carbureted	-3	-7	-5	-6	-10
TWC/Carbureted or TBI	-11	-7	-4	-9	-7
TWC/Fuel Injected	-2	-2	-14	-5	-5
Bag 2					
No Catalyst/Carbureted	-8	+9	--	--	--
Oxy Catalyst/Carbureted	+29	+30	-4	+43	+38
TWC/Carbureted or TBI	0	-8	+5	+3	-13
TWC/Fuel Injected	-30	-25	-17	-13	+1
Bag 3					
No Catalyst/Carbureted	-15	-8	--	--	--
Oxy Catalyst/Carbureted	+12	**+5**	-5	+21	+11
TWC/Carbureted or TBI	**-18**	**-19**	-15	-9	-12
TWC/Fuel Injected	-28	-22	-23	-15	-2
Composite					
No Catalyst/Carbureted	-5	+3	--	--	--
Oxy Catalyst/Carbureted	+13	+10	-5	+20	+14
TWC/Carbureted or TBI	**-14**	-13	-11	-9	-8
TWC/Fuel Injected	-13	-12	**-15**	-8	-5

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 14 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in CO Emissions (g/mile)

FTP Bag & Technology Group	Phase2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	-13	+5	--	--	--
Oxy Catalyst/Carbureted	-18	-2	+203	-70	-69
TWC/Carbureted or TBI	-3	-2	0	-3	-20
TWC/Fuel Injected	+3	-1	-19	+1	-4
Bag 2					
No Catalyst/Carbureted	-39	0	--	--	--
Oxy Catalyst/Carbureted	-22	-3	+2	-10	+1
TWC/Carbureted or TBI	+10	-3	+15	+15	-17
TWC/Fuel Injected	-63	-2	-60	-35	-5
Bag 3					
No Catalyst/Carbureted	-58	0	--	--	--
Oxy Catalyst/Carbureted	**-17**	0	-4	-15	-13
TWC/Carbureted or TBI	-18	-2	-21	+9	+1
TWC/Fuel Injected	-43	0	-28	-34	-27
Composite					
No Catalyst/Carbureted	-35	+1	--	--	--
Oxy Catalyst/Carbureted	-17	-2	+33	-34	-29
TWC/Carbureted or TBI	-6	-3	-3	+2	-14
TWC/Fuel Injected	-17	-2	-26	-11	-10

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 15 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in CO_2 Emissions (g/mile)

FTP Bag & Technology Group	Phase2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	+5	+5	--	--	--
Oxy Catalyst/Carbureted	0	-2	+20	-16	-18
TWC/Carbureted or TBI	-2	-2	-2	-3	0
TWC/Fuel Injected	-2	-1	+6	-6	-5
Bag 2					
No Catalyst/Carbureted	+1	0	--	--	--
Oxy Catalyst/Carbureted	-2	-3	+22	-9	-8
TWC/Carbureted or TBI	-2	-3	-2	**-4**	-3
TWC/Fuel Injected	-2	-2	+8	-8	-9
Bag 3					
No Catalyst/Carbureted	0	0	--	--	--
Oxy Catalyst/Carbureted	-1	0	+23	-20	-18
TWC/Carbureted or TBI	-2	-2	+1	-4	-3
TWC/Fuel Injected	0	0	+6	-6	-6
Composite					
No Catalyst/Carbureted	+1	+1	--	--	--
Oxy Catalyst/Carbureted	-1	-2	+22	-19	-18
TWC/Carbureted or TBI	-2	-3	-1	-4	-3
TWC/Fuel Injected	-2	-2	+8	-7	-7

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 16 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in NO_x Emissions (g/mile)

FTP Bag & Technology Group	Phase2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	-3	-5	--	--	--
Oxy Catalyst/Carbureted	-2	+1	-10	0	+8
TWC/Carbureted or TBI	-6	-5	-6	-5	+1
TWC/Fuel Injected	-16	**-19**	**-12**	-4	-6
Bag 2					
No Catalyst/Carbureted	0	-5	--	--	--
Oxy Catalyst/Carbureted	+3	+12	-4	+6	+11
TWC/Carbureted or TBI	**-12**	-15	-7	**-9**	-14
TWC/Fuel Injected	-1	**-16**	-10	+9	-4
Bag 3					
No Catalyst/Carbureted	-12	-14	--	--	--
Oxy Catalyst/Carbureted	-6	0	-20	-1	-15
TWC/Carbureted or TBI	-15	-14	-15	-9	-3
TWC/Fuel Injected	-10	-6	-1	-8	+2
Composite					
No Catalyst/Carbureted	-5	-8	--	--	--
Oxy Catalyst/Carbureted	-1	+6	-11	+3	+12
TWC/Carbureted or TBI	-10	-11	-8	**-7**	-5
TWC/Fuel Injected	-8	-14	-8	+1	-2

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

vehicles, especially for bag 1 and the FTP composite in TWC/FI vehicles. *In general, the reduction in fuel benzene (and aromatics) seems to be effective in reducing exhaust benzene emissions, regardless of vehicle technology.*

5. Exhaust 1,3-Butadiene by Vehicle Technology. Table 18 shows that all of the statistically significant reductions in 1,3-butadiene emissions were found to involve Phase 2 (compared to Base and Phase 1) in the TWC technology groups regardless of fuel delivery system. None of the other fuel comparisons were responsive to differences in vehicle technology. *There was a statistically significant reduction in 1,3-butadiene emissions for both of the TWC technology groups when Phase 2 was compared to both Base and Phase 1.*

6. Exhaust Formaldehyde by Vehicle Technology. As shown in Table 19, all of the statistically significant increases in formaldehyde emissions (due to the presence of an oxygenate in the fuel) involved the TWC technology groups. All the technology groups reflected the trend towards an increase due to the use of Phase 2 or SBE. As explained in V.A.7., *Exhaust Formaldehyde*, this increase is not expected to increase the overall toxicity of Phase 2 gasoline. *In general, both Phase 2 and SBE produced higher FTP bag 1 formaldehyde emissions when compared to Base for the TWC technology groups.*

7. Exhaust Acetaldehyde by Vehicle Technology. As for formaldehyde, most of the statistically significant differences for acetaldehyde emissions were found to involve the TWC technology groups, although the Oxy Cat group responded with an increase when Phase 2 was compared to Phase 1. These effects are shown in Table 20. Unexpectedly, Phase 2 showed statistically significant decreases compared to Phase 1 and Base in the TWC/Carb or TBI technology in bag 1, 3 and the FTP composite, but had the opposite effect (an increase) in the Oxy Cat technology compared to Phase 1, in bags 2, 3 and the FTP composite. Increases in exhaust acetaldehyde for SBE were apparent across all technologies, statistically significantly so for TWC-equipped vehicles. *SBE, regardless of vehicle technology type, produced increased levels of exhaust acetaldehyde when compared to each of the other test fuels however, all of the statistically significant results involved the TWC technology groups. Phase 2 produced greater levels of exhaust acetaldehyde emissions when compared to Phase 1 in the Oxy Cat/Carb technology group but lower levels when compared to the TWC/Carb or TBI group.*

Table 17 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in Benzene Emissions (g/mile)

FTP Bag & Technology Group	Phase2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	+26	-26	--	--	--
Oxy Catalyst/Carbureted	**-38**	-35	-15	-26	-20
TWC/Carbureted or TBI	**-36**	**-40**	-14	-25	-34
TWC/Fuel Injected	**-38**	-35	**-24**	**-28**	**-26**
Bag 2					
No Catalyst/Carbureted	-31	-21	--	--	--
Oxy Catalyst/Carbureted	-18	-17	-19	-3	+2
TWC/Carbureted or TBI	-13	-25	+75	-38	-53
TWC/Fuel Injected	-47	**-38**	-15	-36	-5
Bag 3					
No Catalyst/Carbureted	-43	-39	--	--	--
Oxy Catalyst/Carbureted	**-35**	-30	-15	-21	-9
TWC/Carbureted or TBI	**-38**	**-42**	**-23**	**-22**	-30
TWC/Fuel Injected	**-59**	**-56**	-43	-38	-29
Composite					
No Catalyst/Carbureted	-25	-27	--	--	--
Oxy Catalyst/Carbureted	**-31**	-29	-17	-15	-8
TWC/Carbureted or TBI	**-34**	**-38**	-10	-26	**-35**
TWC/Fuel Injected	-46	**-41**	-29	**-34**	**-25**

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 18 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in 1,3-Butadiene Emissions (g/mile)

FTP Bag & Technology Group	Phase2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	+56	+2	--	--	--
Oxy Catalyst/Carbureted	-23	-11	-15	-15	+6
TWC/Carbureted or TBI	**-34**	**-35**	-20	-21	-24
TWC/Fuel Injected	-21	**-20**	-11	-14	-12
Bag 2					
No Catalyst/Carbureted	-8	-5	--	--	--
Oxy Catalyst/Carbureted	+12	+5	-13	+26	+19
TWC/Carbureted or TBI	-41	-45	-41	-18	-19
TWC/Fuel Injected					
Bag 3					
No Catalyst/Carbureted	-5	-10	--	--	--
Oxy Catalyst/Carbureted	-5	-8	-15	+6	+21
TWC/Carbureted or TBI	**-39**	-41	-39	-11	-16
TWC/Fuel Injected	-9	-18	0	-17	0
Composite					
No Catalyst/Carbureted	+3	0	--	--	--
Oxy Catalyst/Carbureted	-9	-6	-14	+7	+16
TWC/Carbureted or TBI	**-39**	**-39**	-21	-29	-33
TWC/Fuel Injected	-21	**-21**	-12	-18	-11

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 19 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in Formaldehyde Emissions (g/mile)

FTP Bag & Technology Group	Phase 2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Bag 1					
No Catalyst/Carbureted	+23	+21	--	--	--
Oxy Catalyst/Carbureted	+9	+34	-8	-8	+24
TWC/Carbureted or TBI	**+31**	+19	+10	**+31**	+26
TWC/Fuel Injected	+51	**+40**	+32	-4	+2
Bag 2					
No Catalyst/Carbureted	+33	+26	--	--	--
Oxy Catalyst/Carbureted	+31	+50	-3	+16	+30
TWC/Carbureted or TBI	+17	+12	-10	+18	+19
TWC/Fuel Injected	+36	+53	-18	+44	+4
Bag 3					
No Catalyst/Carbureted	+44	+31	--	--	--
Oxy Catalyst/Carbureted	+11	+22	-9	-3	+16
TWC/Carbureted or TBI	**+41**	+34	+33	+3	+15
TWC/Fuel Injected	+23	-3	-5	+14	+8
Composite					
No Catalyst/Carbureted	+34	+26	--	--	--
Oxy Catalyst/Carbureted	+21	+38	-6	+6	+25
TWC/Carbureted or TBI	+27	+18	-6	+28	+29
TWC/Fuel Injected	+43	+29	+20	+4	+2

Enlarged and bold face type indicates significance at the 95% or higher level.

SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 20 - Phase 2 and SBE Effects for Exhaust Emissions by Vehicle Technology - % Change in Acetaldehyde Emissions (g/mile)

FTP Bag & Technology Group	Phase 2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
FTP Bag 1					
No Catalyst/Carbureted	+17	+10	--	--	--
Oxy Catalyst/Carbureted	0	+15	-37	+39	+73
TWC/Carbureted or TBI	**-12**	**-15**	-57	+99	+93
TWC/Fuel Injected	+12	+6	**-47**	**+83**	**+90**
FTP Bag 2					
No Catalyst/Carbureted	+28	+16	--	--	--
Oxy Catalyst/Carbureted	+23	**+32**	-28	+67	+79
TWC/Carbureted or TBI	-26	-27	-71	**+110**	+126
TWC/Fuel Injected	-38	-24	-21	-31	-31
FTP Bag 3					
No Catalyst/Carbureted	+52	+19	--	--	--
Oxy Catalyst/Carbureted	+12	**+10**	-32	+58	+61
TWC/Carbureted or TBI	-20	**-23**	**-66**	+94	**+120**
TWC/Fuel Injected	-22	-41	-31	-4	-20
FTP Composite					
No Catalyst/Carbureted	+32	+16	--	--	--
Oxy Catalyst/Carbureted	+15	**+22**	-31	+59	+74
TWC/Carbureted or TBI	-21	**-26**	-67	+98	+98
TWC/Fuel Injected	-5	-7	**-46**	**+63**	+67

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

C. FUEL EFFECTS ON EVAPORATIVE EMISSIONS

Paired-t tests were employed to investigate fuel effects on evaporative emissions independent of vehicle technology. Evaporative HC emissions were analyzed for the Running Loss, Hot Soak, and the VT SHED tests. The numbers displayed in bold in Table 21 are those changes (%) in emissions that were statistically significant at at least the 95% confidence level, the format which has been employed for all tables. Evaporative benzene emissions were analyzed for the Running Loss tests only. As mentioned above, the test data from vehicles 7 and 9 were excluded from the statistical analysis of the evaporative emissions data at the direction of the ARB.

1. Running Loss Evaporative HC and benzene. There were no statistically significant differences between fuels for evaporative HC emissions during the Running Loss tests, except for the Phase 2 to SBE comparison which showed a statistically significant reduction for the Phase 2 fuel in the second phase of the test. The trend for all Running Loss tests involving Phase 2 was a reduction in hydrocarbon emissions, as was expected due to its low volatility. It should be noted that the trend for SBE compared to the volatility-matched (7.6 psi RVP) Phase 1 was a consistent increase in hydrocarbon emissions, although none of the comparisons produced a statistically significant result. *The only statistically significant evaporative HC reduction occurred with the Phase 2 fuel in the Phase 2/SBE comparison during the Running Loss tests for this vehicle fleet, regardless of the differences in fuel volatility (RVP).*

2. Hot Soak Evaporative HC. None of the comparisons between test fuels produced a statistically significant result for Hot Soak emissions, although in general increases or decreases mirrored differences in volatility. *None of the test fuels produced statistically significantly higher or lower evaporative HC emissions during the Hot Soak tests for this vehicle fleet.*

3. VT SHED Evaporative HC. There were a large number of strongly statistically significant differences between Phase 2 and the other fuels for the VT SHED tests. In particular, Phase 2 produced statistically significantly lower evaporative HC emissions than Base and SBE during all three days of the VT SHED tests, and produced statistically significantly lower HC emissions than Phase 1 during the second and third days of the VT SHED tests. Additionally, Phase 1 produced statistically significantly lower HC emissions than Base for the entire VT SHED test. All of the differences follow the RVP differences

Table 21 - Fuel Effects for Evaporative Emissions - % Change in Emissions

Test	Phase 1/Base	Phase 2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Running Loss HC (g/mile)						
Phase1	-14	-14	+1	-4	-11	+20
Phase 2	-12	-23	-13	**-50**	+60	+78
Phase 3	-26	-38	-17	-74	-180	+180
Total	-23	-28	-6	-60	-110	+150
Running Loss benzene (mg/mile)						
Total	0	0	0	0	0	0
Hot Soak HC (g/test)						
Test	-60	-70	-26	-89	+10	+420
VT SHED HC (g/day)						
Day 1	**-31**	**-48**	-25	**-46**	-28	+22
Day 2	**-40**	**-59**	**-33**	**-47**	-41	+15
Day 3	**-23**	**-46**	**-40**	**-39**	-33	-2

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

between the individual test fuels found in Appendix B. Results of the comparisons done for SBE/Base were insignificant reductions. There was no statistically significant difference between SBE and Phase 1.

SBE produced greater evaporative HC emissions than any of the other test fuels in the program. Even though the RVPs of both SBE and Phase 1 were the same (7.6 psi), SBE still produced higher evaporative HC emissions. Ethanol has been shown to produce higher evaporative emissions in RVP matched fuels.[7] The 1.0 psi RVP increase in SBE relative to Phase 2 produced statistically significantly higher levels of evaporative emissions when compared to each of the other test fuels. The superior performance of Phase 2 for evaporative emissions appears to be directly related to the low RVP (6.6 psi) of the fuel. *The evaporative HC emissions during the VT SHED tests for this vehicle fleet are directly related to the RVP of the test fuel. Phase 2 produced the lowest evaporative HC emissions followed by Phase 1.*

D. FUEL EFFECTS ON EVAPORATIVE EMISSIONS BY VEHICLE TECHNOLOGY

Paired-t tests were employed in an effort to investigate fuel effects on evaporative emissions by vehicle technology. The technology groups were defined by the ARB in an effort to relate the resulting data to the ARB predictive model and represent five combinations of model year, canister configuration, and fuel metering systems present in this particular vehicle fleet. These groups are described in detail in Table 7. Note that the number of vehicles in each technology group varies from one to three. Therefore, the statistical power associated with the paired-t tests for evaluating fuel effects by technology is very low. For technology groups represented by only a single vehicle, simple ratios of fuel effects on emissions are reported (ratios of the actual results from tests on two fuels), but a paired-t test result could not be reported. It should also be noted that a paired-t test result could not be reported for two of the technology groups for SBE tests since only one vehicle in each technology group (Post-80/Cl/Carb and Pre-80/Op/Carb) was tested on that fuel. As previously mentioned, when interpreting the findings of this study, it is as important to look for consistent patterns of differences as it is to examine the calculated significance levels of individual differences. For this discussion however, the focus will remain on results which were statistically significant at the 95% or greater confidence level. The test data from vehicles 7 and 9 (Plymouth Reliant and Chevrolet Cavalier) were excluded from the statistical analysis of the evaporative emissions tests at the direction of the ARB.

*1. **Running Loss Evaporative HC by Vehicle Technology.*** The number and strength of statistically significant evaporative HC results is even less than what would be considered consistent with random statistical variation, nor were any trends in the data observable (Table 22). *None of the technology groups show any statistically significant response to fuel effects for evaporative HC emissions during the Running Loss tests for this vehicle fleet.*

*2. **Running Loss Evaporative Benzene Emissions by Vehicle Technology.*** The statistically significant differences found during the Running Loss test with respect to benzene were from two different carbureted vehicle groups, as shown in Table 23. Phase 2 produced reductions in Running Loss benzene emissions in all technologies, but significantly less in the more modern technology group, Post-80/Cl/Carb. Results by technology for Phase 2 versus Phase 1 were mixed, but Phase 2 provided a statistically significant reduction in Running Loss benzene in the oldest technology group, Pre-80/Op/Carb. SBE showed a trend towards a reduction in Running Loss benzene compared to Base, but none of the comparisons were statistically significant. SBE produced mixed results in comparison to Phase 1. *Phase 2 produced lower Running Loss evaporative benzene emissions than Base in the Post-80/Cl/Carb vehicles and less than Phase 1 in the Pre-80/Op/Carb vehicles from this vehicle fleet.*

*3. **VT SHED Evaporative HC by Vehicle Technology.*** As with the Running Loss tests, all of the statistically significant VT SHED evaporative HC results again occurred in the two most disparate technology groups and involved a reduction due to the use of Phase 2 (Table 24). Phase 2 produced statistically significant reductions versus Base in the most modern of the technologies, Post-80/Cl/FI, in all three days of the VT SHED test. It also outperformed Phase 1 on days 2 and 3 and SBE on day 3 in the same technology group. Although a trend following RVP is obvious (if not significant) for the rest of the fuel/technology interactions, it is noteworthy that Phase 2 also produced significantly lower hydrocarbon emissions than Phase 1 on days 2 and 3 in the oldest technology group (Pre-80/Op/Carb). *For this vehicle fleet, Phase 2 gave a statistically significant reduction in VT SHED evaporative HC emissions when compared to each of the other test fuels in the Post-80/Cl/FI technology group. Phase 2 also produced a statistically* *significant reduction in levels of VT SHED evaporative HC emissions compared to Phase 1 when the Pre-80/Op/Carb technology group was tested.*

4. Hot Soak Evaporative HC by Vehicle Technology. The only statistically significant differences between fuels for evaporative HC Hot Soak emissions involved the Post-80/Cl/FI technology group, where the low volatility Phase 2 showed a reduction compared to Base and SBE (Table 24). SBE produced significantly more hydrocarbon emissions than Phase 1 in the same technology. The other vehicle technologies were not significantly responsive to differences in test fuels, nor were the expected trends (more emissions for higher volatility fuels) observed. *Modern vehicles (Post-80/Cl/FI) produce less evaporative Hot Soak emissions with Phase 1 or Phase 2 than with Base or SBE for this vehicle fleet.*

Table 22 - Phase 2 and SBE Effects for Evaporative Running Loss Emissions by Vehicle Technology - % Change in HC Emissions (g/mile)

RL Phase & Technology Group	Phase 2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Running Loss Phase 1					
Post-80/Cl/Carb	-52	-10	-24	-65	0
Post-80/Cl/FI	+31	+36	+23	+21	+33
Post-80/Op/FI	-47	-17	-37	-16	+31
Pre-80/Cl/Carb	-5	-37	--	--	--
Pre-80/Op/Carb	-13	-13	+8	-7	-22
Running Loss Phase 2					
Post-80/Cl/Carb	-40	-14	-59	-1	+76
Post-80/Cl/FI	-45	-34	-52	+56	+28
Post-80/Op/FI	-9	+19	-24	+21	+58
Pre-80/Cl/Carb	+14	-26	--	--	--
Pre-80/Op/Carb	-11	-4	+11	+4	-2
Running Loss Phase 3					
Post-80/Cl/Carb	-43	-19	-61	+11	+82
Post-80/Cl/FI	-81	-41	-62	+65	+15
Post-80/Op/FI	-24	+12	+16	-34	-4
Pre-80/Cl/Carb	+45	-7	--	--	--
Pre-80/Op/Carb	-15	-4	-17	+24	+20
Running Loss Total					
Post-80/Cl/Carb	-44	-15	-55	-17	+62
Post-80/Cl/FI	-47	-5	-23	+41	+26
Post-80/Op/FI	-28	+4	-20	-10	+30
Pre-80/Cl/Carb	+13	-26	--	--	--
Pre-80/Op/Carb	-12	-7	-2	+9	0

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 23 - Phase 2 and SBE Effects for Evaporative Running Loss Emissions by Vehicle Technology - % Change in benzene Emissions (mg/mile)

Running Loss Total & Technology Group	Phase 2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
Running Loss Total					
Post-80/Cl/Carb	**-34**	+21	0	-33	+100
Post-80/Cl/FI	-64	-42	-35	-15	-11
Post-80/Op/FI	--	--	--	--	--
Pre-80/Cl/Carb	-56	-57	--	--	--
Pre-80/Op/Carb	-35	**-29**	+41	-33	-29

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

Table 24 - Phase 2 and SBE Effects for Evaporative VT SHED and Hot Soak Emissions by Vehicle Technology - % Change in HC Emissions (g/day and g/test)

VT SHED Day & Technology Group	Phase 2/Base	Phase 2/Phase 1	Phase 2/SBE	SBE/Base	SBE/Phase 1
VT SHED Day 1					
Post-80/Cl/Carb	-24	+40	+5	-33	+110
Post-80/Cl/FI	**-50**	-42	-45	-18	0
Post-80/Op/FI	-77	-12	-42	-60	+52
Pre-80/Cl/Carb	-53	-39	--	--	--
Pre-80/Op/Carb	-60	-45	-48	-42	+1
VT SHED Day 2					
Post-80/Cl/Carb	-35	+12	-17	-14	+100
Post-80/Cl/FI	**-79**	**-48**	-46	-59	+6
Post-80/Op/FI	-90	-72	-72	-63	+3
Pre-80/Cl/Carb	-35	-28	--	--	--
Pre-80/Op/Carb	-37	**-23**	-21	-30	-1
VT SHED Day 3					
Post-80/Cl/Carb	-56	-28	-19	-15	+78
Post-80/Cl/FI	**-75**	**-62**	**-42**	-51	-30
Post-80/Op/FI	-73	-56	-54	-42	-3
Pre-80/Cl/Carb	-34	-28	--	--	--
Pre-80/Op/Carb	-33	**-19**	-22	-20	+6
Hot Soak					
Post-80/Cl/Carb	+36	-20	+52	+6	-5
Post-80/Cl/FI	**-97**	-22	**-99**	+47	**+5100**
Post-80/Op/FI	-96	+5	-21	-95	+33
Pre-80/Cl/Carb	+84	+76	--	--	--
Pre-80/Op/Carb	-11	+52	-44	-52	+200

Enlarged and bold face type indicates significance at the 95% or higher level.
SBE was not tested on vehicles 3,7,8,10, and 11. All comparisons involving SBE only consider data from vehicles 1,2,5,9,12, and 13.

VI. RECOMMENDATIONS

The comprehensiveness of the statistical analysis of the data was somewhat hampered by the size of the vehicle fleet, with several instances in which statistical categories contained data from either zero or one vehicle. Thus, one obvious recommendation would be additional testing with a larger vehicle fleet. Since financial considerations often play a major role in the final design of any test program, the following recommendations are offered as methods of increasing useful data with minimum additional costs for future programs:

The statistical design of the program should be addressed first. If the resulting data is to be analyzed as a representative fleet of California vehicles, the addition of some late model vehicles would be necessary. However, if the intention of the program would be to match the resulting data to the ARB predictive model, an effort would have to be made to match the test vehicles to the technology groups employed in the model. In order to keep the total number of test vehicles at a reasonable level, only two or three technology groups should be included. This would require eight to twelve test vehicles to provide four vehicles within each technology group.

The test fuels used for this program provided a good historical view of California commercial fuels over the previous five years. These fuels ranged from a pre-1992 California Base fuel to the 1996 Phase 2 fuel. Unfortunately, due to budgetary restraints SBE was only tested in six of the eleven test vehicles. Due to this lack of test data, a *sizable portion* of the SBE test results could not be analyzed statistically. Since comparisons of the Base and Phase 1 are plentiful it is suggested that Base be removed from future studies and additional testing be performed on SBE. Additionally, to accurately compare and contrast the effects of MTBE and ethanol as oxygenates, the option of testing a pair of RVP matched Phase 2 type fuels using MTBE and ethanol as the oxygenate should be investigated.

Appendix A Key Specifications of the Vehicle Fleet

Vch #	Year	Make & Model	Odometer	VIN	Emission Controls	Adaptive Learn	Canister Bottom	Engine	Fuel Delivery	EGR	Air Injection
1	1990	Oldsmobile Calais	19,800	1G3NK54D1LM758792	CL/TWC	Yes	Closed	2.3L	Fuel Inj	No	No
2	1985	Chevrolet Blazer	58,700	1G8CS18B9F8272246	CL/TWC	No	Closed	2.8L	Carbureted	Yes	Yes
3	1973	Oldsmobile Cutlass	135,900	3J29K3M398333	OL/NO	No	Open	350 CID	Carbureted	Yes	No
5	1990	Honda Accord	13,100	1HGCB7543LA000067	CL/TWC	Yes	Open	2.2L	Fuel Inj	Yes	No
7	1983	Plymouth Reliant	88,600	1P3BP26CXDF304361	CL/TWC	No	Closed	2.2L	Carbureted	Yes	Yes
8	1987	Ford Escort	68,200	1FAPP23J6HW304524	CL/TWC	Yes	Closed	1.9L	Fuel Inj	Yes	Yes
9	1986	Chevrolet Cavalier	79,100	1G1JD77P0GJ294422	CL/TWC	Yes	Open	2.0L	Fuel Inj	Yes	No
10	1976	Ford Granada	80,400	F6W83H279879	OL/OXY	No	Closed	351 CID	Carbureted	Yes	Yes
11	1984	Chrysler New Yorker	103,800	1C3BF66PXEX500443	CL/TWC	No	Closed	318 CID	Carbureted	Yes	Yes
12	1978	Toyota Celica	158,900	RA29147581	OL/OXY	No	Open	2.2L	Carbureted	Yes	Yes
13a	1989	Ford Taurus	18,700	1FABP52U3KG188031	CL/TWC	Yes	Closed	3.0L	Fuel Inj	No	No

Appendix B Test Fuel Specifications

Fuel Parameter	Units	California Base Fuel	California Phase I Fuel	California Phase 2 Fuel	California SBE Fuel
Octane (R&M)/2. Min.	–	89	89	89	89
Distillation Range					
Initial Boiling Point	deg. F	75 - 100	75 - 100	report	report
10% Point **	deg. F	120 - 140	120 - 140	130 - 150	130 - 150
50% Point **	deg. F	200 - 230*	200 - 230	190 - 210	200 - 210
90% Point **	deg. F	300 - 325*	300 - 325	290 - 300	290 - 300
End Point	deg. F	415 max	415 max	390 max	390 max
Sulfur	ppmw	125 - 175*	125 - 175	30 - 40	30 - 40
Reid Vapor Pressure	psi	8.7 - 9.0*	7.5 - 8.0	6.7 - 7.0	7.7 - 8.0
Olefins	vol %	9.0 - 11.0	9.0 - 11.0	4.0 - 5.0	4.0 - 5.0
Aromatic Hydrocarbons	vol %	29.0 - 35.0	29.0 - 35.0	22 - 25	22 - 25
Multi-Substituted Alkyl Aromatic Hydrocarbons	vol %	18 - 24	18 - 24	12 - 14	12 - 14
Paraffins	vol %	report	report	report	report
Benzene	vol %	1.4 - 2.0	1.4 - 2.0	0.8 - 1.0	0.8 - 1.0
MTBE	vol %	0	0	10.8 - 11.2	0
Ethanol	vol %	0	0	0	5.75
Lead	gram/gal	0.05 max	0.05 max	0.05 max	0.05 max
Phosphorus	gram/gal	0.005 max	0.005 max	0.005 max	0.005 max
Deposit Control Additives (yes/no)	-	report	yes	yes	yes
Carbon	wt %	report	report	report	report
Hydrogen	wt %	report	report	report	report

N/A - Not Applicable
* - Most Critical Parameters
** - Difference between Driveability Index for Base and Phase I Fuel must be less than 50.
DI = 1.5*T10 + 3.0*T50 + T90

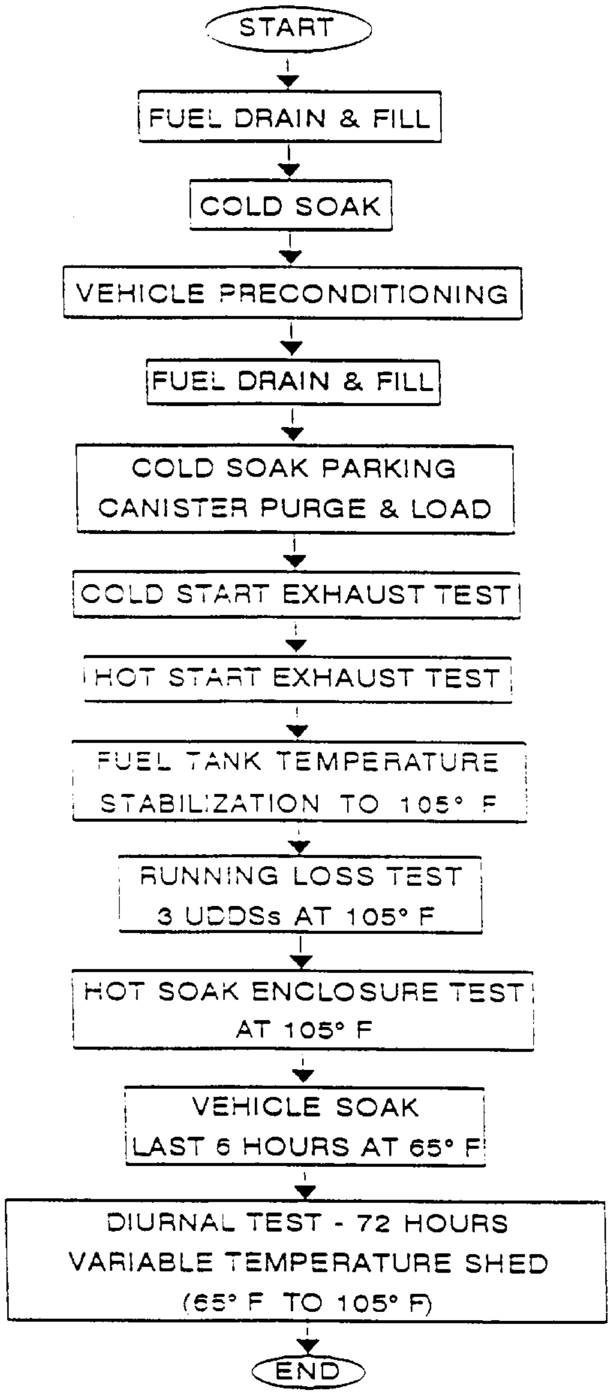
Appendix C Independent Fuel Analysis Results

Property	Base		Phase 1		Phase 2[1]		SBE	
Octane, (R+M)/2	90		92		92		91	
Distillation Range, °F								
IBP	80		87		97		99	
10%	126		132		140		132	
50%	223		226		198		210	
90%	312		313		290		296	
End Point	401		408		373		374	
Sulfur, ppm	134		138		36		37	
Reid Vapor Pressure, psi	8.7		7.6		6.6		7.6	
Components, vol% (DHA results)								
olefins	9.4	(8.6)	8.5	(8.9)	6.1	(6.2)	5.6	(6.6)
aromatic hydrocarbons	32.6	(30.4)	33.1	(30.7)	26.9	(24.6)	25.8	(25.2)
paraffins	57.9	(58.9)	58.5	(58.3)	61.6	(56.4)	62.4	(61.4)
benzene	1.45		1.46		0.93		0.93	
multi-substituted alkyl aromatic hydrocarbons		(15.2)		(15.4)		(13.8)		(14.1)
MTBE	--		--		10.7	(11.8)	--	
ethanol	--		--		--		5.6	(5.9)
unknown		(2.1)		(2.1)		(0.9)		(0.9)
Lead, TEL, g/gal	0		0		0.005		0.008	
Phosphorus, g/gal	0		0		0		0	
Carbon, wt%	86.57		86.49		84.01		83.46	
Hydrogen, wt%	13.43		13.51		14.12		14.63	
Oxygen, wt%	--		--		1.91		1.97	
Specific Gravity	0.7456		0.7498		0.7397		0.7402	
Heating Value (net), BTU/lb	18547		18509		18405		18391	

Note: Phase 2 and SBE have the same hydrocarbon base but different oxygenates

1 The test fuel labeled as Phase 2 does not exactly conform to current ARB Phase 2 gasoline specifications but, is in fact, a very similar representation.

Appendix D Test Flow Schedule



Appendix D (cont.) Program Flow Sequence

1. Initial Vehicle Inspection
2. Vehicle Canister Capacity Determination
3. California Evaporative Emissions Test Procedure (92-10) - Test #1 Fuel #1
4. California Evaporative Emissions Test Procedure (92-10) - Test #2 Fuel #2
5. QC FTP - QC #1 Fuel #1
6. California Evaporative Emissions Test Procedure (92-10) - Test #3 Fuel #3
7. California Evaporative Emissions Test Procedure (92-10) - Test #4 Fuel #4 (if required)
8. QC FTP - QC #2 Fuel #1
9. Vehicle Purge Flow Measurement
10. Vehicle Test Matrix Complete

Appendix E Adaptive Learn Pre-preconditioning Sequence

Between tests with different fuels

1. Purge canister @ 48 scfh for 60 min.
2. Drain fuel tank
3. Add 5 gallons test fuel
4. Drive 50 miles
5. Drain fuel tank
6. Add 3 gallons test fuel
7. Start engine - one min. idle
8. Drain fuel tank
9. 40% fill test fuel @ 76°F
10. UDDS preconditioning cycle
11. Engine off - five min. soak
12. Start engine - one min. idle
13. Engine off - five min. soak
14. Start engine - one min. idle
15. Engine off - five min. soak
16. UDDS preconditioning cycle
17. Begin test sequence

Appendix F Canister Preparation Record

VEH # ______ DATE ______
VEH MAKE ______ OPERATOR ______
VEH MODEL ______

REMOVAL / REINSTALLATION OF CANISTER

HOSE CONNECTIONS

REMOVED BY ____________ DATE ______ ______ AM / PM OK___NOT OK______*

INSTALLED BY ____________ DATE ______ ______ AM / PM OK___NOT OK______*

* COMMENTS IF "NOT OK":

CANISTER LABEL INFORMATION

PURGE TIME ______ MIN
LOAD TIME ______ HRS ______ MIN
APROX PURGED WT ______ gm.

PURGE RECORD

CANISTER PURGED BY ____________ DATE ______ TIME ______ AM / PM
AMBIENT (DRY BULB) TEMPERATURE ______ °F LOCATION ____________
MEASURED RELATIVE HUMIDITY (USING SLING PSYCHROMETER) ______ %
REQUIRE RELATIVE HUMIDITY (FROM CHART ON NEXT PAGE)
MINIMUM ______ % MAXIMUM ______ %

SPECIFIED FLOW RATE: 48 scfm

TIME PURGE STARTED ______ FLOW RATE ______ scfm
TIME PURGE ENDED ______ FLOW RATE ______ scfm
NET PURGE TIME ______ MIN
TIMER USED Y / N

Appendix F (cont.) Additional Canister Preparation Form
(Reflected ARB's change in relative humidity requirement)

LOAD RECORD

CANISTER LOADED BY __________ DATE _____ TIME _____ AM / PM

1. TARGET VOLUMETRIC FLOW RATE FOR EACH GAS:

104 ml/min * ((________ °F + 460) / 531) * (29.92 / ________ mm Hg (Baro)) = ________ ml / min

ACCEPTABLE RANGE (± 7 ml/min): _____ TO _____ml/min

2. ACTUAL MEASURED FLOW RATES:

	AT SET-UP	AT COMPLETION
BUTANE	__________ ml/min	__________ ml/min
NITROGEN	__________ ml/min	__________ ml/min

3. LOADING:

TIME STARTED	_____ AM / PM	INITIAL WEIGHT	_____ gm
TIME ENDED	_____ AM / PM	FINAL WEIGHT	_____ gm
NET LOAD TIME	_____ HRS	NET BUTANE	_____ gm
	_____ MIN		

FLOW TIMER USED _____ YES _____ NO

RELATIVE HUMIDITY CHART

	% RELATIVE HUMIDITY REQUIRED	
DRY BULB TEMP °F	LOWER LIMIT	UPPER LIMIT
69	62	80
70	60	78
71	58	76
72	56	73
73	54	71
74	52	68
75	50	~~70~~ 66

Appendix F (cont.) Additional Canister Preparation Form
(Reflected ARB's change in relative humidity requirement)

Client/Project ID ____________________

Vehicle: Make ____________ Veh. ID # ____________

Canister Removal/Reinstallation Record

	Date	Time	Check Hose Connections OK	not OK*
Removed by		am / pm		
Reinstalled by		am / pm		

Comments, if "not OK" is checked:

Information from Canister Label Purge Time ________ min.
Load Time ________ hrs. ________ min.
Approximate Purged Weight ________ grams

Canister Purge Record

Canister purged by ____________________ Date ____________ Time ________ am / pm
Conditions: Temperature ________ °F Percent Relative Humidity ____________
Acceptable Humidity Range (from chart, below): Minimum: ____ % Maximum: _____ %

*******The specified purge flow rate is 48 scf/hr*******

Time Purge Flow Ended ________ Flow Rate at End ________ scf/hr
Time Purge Flow Started ________ Flow Rate at Start ________ scf/hr
Net Purge Time ________ min.

Percent Relative Humidity corresponding to 50 ± 10 grains water per pound of dry air:

Temp., °F	% RH Range Lower	Upper	Temp., °F	% RH Range Lower	Upper
65	42.3	65.1	73	32.1	49.3
66	40.8	62.7	74	31.1	47.9
67	39.5	60.8	75	30.0	46.2
68	38.1	58.3	76	29.1	44.8
69	36.7	56.4	77	28.1	43.2
70	35.6	54.7	78	27.1	41.7
71	34.3	52.8	79	26.3	40.5
72	33.3	51.2	80	25.4	39.1

Appendix G Description of Paired-t Test Approach

The paired-t test is described in most introductory texts on statistical methods. Often it is referred to as the student-t test for the analysis of two dependent variables. Essentially it is equivalent to conducting a student-t test on the fuel differences calculated for each vehicle.

This appendix illustrates the approach using the following example. Hot Soak evaporative emissions test data Base and Phase 1 tests in the post-80/CI/FI technology group which consists of vehicles 1, 8, and 13.

Table G.1 Hot Soak Test Results and Ln Difference

Vehicle	Base (g)	Phase 1 (g)	Ln (Base)	Ln(Phase 1)	Difference Ln(Phase 1) - Ln(Base)
1	16.490	0.465	2.8028	-0.7657	-3.5685
8	4.259	0.450	1.4490	-0.7985	-2.2475
13	25.060	0.700	3.2213	-0.3567	-3.5779

The paired-t test is based upon the log-differences in the last column of Table G.1. The paired-t test is testing whether these differences are equal to zero. In particular, the traditional null and alternative hypotheses would be:

H_0: Mean(Ln(Phase 1) - Ln(Base))= 0

versus

H_1: Mean(Ln(Phase 1) - Ln(Base))≠0

Using the logarithm properties Ln(a/b) = Ln(a) - Ln(b) and Ln(1) = 0, it is easy to show that this test is equivalent to:

H_0: Mean((Phase 1)/(Base)) = 1

versus

H_1: Mean((Phase 1)/(Base))≠1.

The paired-t test evaluates the significance of this two-sided test by first calculating the average and standard deviation of the differences in the last column:

n = number of differences = 3

Average = [(-3.5685) + (-2.2475) + (-3.5779)]/n = -3.1313

$$S^2 = [((-3.5685-(-3.1313))^2+((-2.2475-(-3.1313))^2+((-3.5779-(-3.1313))^2]/(n-1)= 0.5858$$

$$\text{Std. Dev.} = (S^2)^{1/2} = (0.5858)^{1/2} = 0.7654$$

Using these calculations, the t-test ratio is calculated:

$$t = \frac{(\text{average}) * n^{1/2}}{\text{Std. Dev.}} = \frac{3.1313 * 3^{1/2}}{0.7654} = 7.086$$

The statistical analysis software then calculates the probability that a t-test ratio as large as or greater than this (7.086) could have occurred by chance when there is no difference between the two fuels. In this case, this probability is:

$$\text{Prob}(|t| \geq 7.086 \mid \text{Ho is true}) = 0.0193.$$

This probability, 0.0193, is referred to as the p-value for this test. Since it is less than 0.05, but greater than 0.01, this indicates that there is a statistically significant difference between the two test fuels.

In some reports, the actual p-values are reported, allowing the reader to determine whether they view the difference as statistically significant. The actual p-values were not reported in this report since it would have greatly increased the size of the summary tables. Rather the statistical significance of the results were summarized with footnotes using the following coding:

*	if $0.05 < p < 0.1$
**	if $0.01 < p \leq 0.05$
***	if $0.001 < p \leq 0.01$, and
****	if $p \leq 0.001$.

In some reports, this would have been reported as:

*	90% significance
**	95% significance
***	99% significance
****	99.9% significance.

The result just illustrated for evaluating hot soak differences between Base and Phase 1 in the technology group post-80/CI/FI is found in Table H.22 of Appendix H and is reported under the column labeled Phase 1/Base as 0.04**. The double asterisks indicate that the difference between Base and Phase 1 is statistically significant at the 95% level.

The value of 0.04 is the estimated average ratio for Phase 1/Base. Formally, it is calculated from the average log difference -3.1313 as follows:

$$e^{-3.131} = 0.04$$

This is an estimate of the average effect of Phase 1 divided by the average effect of Base. The value 0.04 indicates that on average, the estimated hot soak emissions from Phase 1 are only 4% of those for Base in the post-80/Cl/FI technology group.

Although this method for estimating the percent difference between Phase 1 and Base is standard within the industry, it may differ from an average compute without using logarithms. In this case without using logarithms, for example, the individual ratios would be as computed in Table G.2:

Table G.2 Hot Soak Test Results and Ratio Difference

Vehicle	Base (g)	Phase 1 (g)	Phase 1/Base Ratio
1	16.490	0.465	0.0282
8	4.259	0.450	0.1057
13	25.060	0.700	0.0279

The average of these ratios would be:

$$\frac{(0.0282 + 0.1057 + 0.0279)}{3} = 0.05$$

which is slightly larger than the estimate provided by using logarithms.

Effect of Phase 1 & Phase 2 Gasolines on Evaporative and Exhaust Emissions

STATISTICAL ANALYSIS RESULTS

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for
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under subcontract to Automotive Testing Laboratories, Inc.
for ARB Contract A132-183

Table H.1 Exhaust HC Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	0.9908	0.9903	0.9851	0.9904
Phase 2/Base	0.9544	0.9135	0.8323**	0.9175
SBE/Base	0.9934	0.9972	0.9225	0.9588
Phase 2/Phase 1	0.9632	0.9224	0.8448***	0.9263
SBE/Phase 1	0.9331	1.0115	0.9651	0.9665
SBE/Phase 2	1.1018**	1.0807	1.2102**	1.1354*

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.2 Exhaust CO Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	0.9955	0.9307	0.9624	0.9893
Phase 2/Base	0.9525	0.6610*	0.6772***	0.8494
SBE/Base	0.8128	0.8273	0.8116	0.8845
Phase 2/Phase 1	0.9568	0.7102*	0.7037****	0.8585
SBE/Phase 1	0.7466	0.9188	0.8367*	0.8495**
SBE/Phase 2	0.9244	1.4968	1.2842**	1.1192

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.3 Exhaust CO2 Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	0.9993	1.0070	1.0016	1.0040
Phase 2/Base	0.7910	0.9820**	0.9907*	0.9854
SBE/Base	0.9350	0.9112*	0.9223	0.9187
Phase 2/Phase 1	0.9198	0.9751**	0.9892	0.9820**
SBE/Phase 1	0.9430	0.9126*	0.9290	0.9227*
SBE/Phase 2	0.9459	0.9368	0.9310	0.9372

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.4 Exhaust NOX Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	0.9939	1.0612	0.9680	1.0169
Phase 2/Base	0.9104**	0.9558	0.8860*	0.9268***
SBE/Base	0.9650	1.0232	0.9248	0.9858
Phase 2/Phase 1	0.9049**	0.9007**	0.9153	0.9114**
SBE/Phase 1	0.9875	0.9503	1.0236	0.9921
SBE/Phase 2	1.1048**	1.0839	1.1054	1.0973*

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.5 Exhaust benzene Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	1.0430	1.0113	0.9904	0.9961
Phase 2/Base	0.6660****	0.7465*	0.5410****	0.6384****
SBE/Base	0.7292****	0.6872*	0.6967**	0.7262***
Phase 2/Phase 1	0.6385****	0.7381***	0.5462****	0.6339****
SBE/Phase 1	0.7237***	0.7266	0.7343***	0.7430***
SBE/Phase 2	1.2340***	0.8252	1.4819**	1.2659**

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.6 Exhaust 1,3-butadiene Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	1.0109	0.9828	1.0325	1.0027
Phase 2/Base	0.7816**	0.8341	0.7729**	0.7518***
SBE/Base	0.8335**	0.9843	0.9252	0.8167
Phase 2/Phase 1	0.7733***	0.7962	0.7486**	0.7558***
SBE/Phase 1	0.8650	0.9797	1.0036	0.8470
SBE/Phase 2	1.1719**	1.4023	1.2400	1.1794*

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.7 Exhaust formaldehyde Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	1.0269	0.9533	1.1044	1.0439
Phase 2/Base	1.3259***	1.2757**	1.2910***	1.3187***
SBE/Base	1.0543	1.3007*	1.0767	1.1184
Phase 2/Phase 1	1.2911****	1.3382	1.1690*	1.2632****
SBE/Phase 1	1.1308	1.1297	1.1145	1.1446
SBE/Phase 2	0.8564	1.1509	0.944	0.9379

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.8 Exhaust acetaldehyde Fuel Ratios

Fuel Ratio	Bag 1	Bag 2	Bag 3	Composite
Phase 1/Base	1.0193	0.9298	1.159	1.0283
Phase 2/Base	1.0121	0.8023	0.8927	0.9465
SBE/Base	1.7950****	1.1633	1.3169	1.7343****
Phase 2/Phase 1	0.9929	0.8628	0.7723**	0.9205
SBE/Phase 1	1.8817****	1.2039	1.2624	1.7790***
SBE/Phase 2	1.9615****	1.2971	1.8328**	2.0953***

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.9 Analysis of FTP HC emissions by vehicle technology

	Average Test Fuel Ratio					
Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	1.02	1.10		1.08		
Oxy Cat/Carb	1.04**	0.97	0.94	0.93	0.90	1.05
TWC/Carb or MI	0.95	0.89	0.91	0.93	0.93	1.04
TWC/FI	1.00	0.98	0.95	0.98	0.95	1.16
Bag 2						
No Cat/Carb	0.85	0.92		1.09		
Oxy Cat/Carb	0.99	1.29	1.43	1.30	1.38	1.04
TWC/Carb or MI	1.10	1.00	1.03	0.92	0.87	0.95
TWC/FI	0.93	0.70	0.87	0.75	1.01	1.20
Bag 3						
No Cat/Carb	0.93	0.85		0.92		
Oxy Cat/Carb	1.06	1.12	1.21	1.05***	1.11	1.05
TWC/Carb or MI	1.02	0.82**	0.91	0.81**	0.88	1.17
TWC/FI	0.93	0.72	0.85	0.78	0.98	1.30
Composite						
No Cat/Carb	0.92	0.95		1.03		
Oxy Cat/Carb	1.03	1.13	1.20	1.10*	1.14	1.05
TWC/Carb or MI	0.98	0.86**	0.91	0.87	0.92	1.12
TWC/FI	1.00	0.87	0.92	0.88	0.95	1.17**

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.10 Analysis of FTP CO emissions by vehicle technology

Technology	Average Test Fuel Ratio Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	0.86	0.87		1.05		
Oxy Cat/Carb	0.96	0.82	0.30	0.98	0.31	0.33
TWC/Carb or MI	0.99	0.97	0.97	0.98	0.80	1.00
TWC/FI	1.06	1.03	1.01	0.99	0.96	1.24
Bag 2						
No Cat/Carb	0.75	0.61		1.00		
Oxy Cat/Carb	0.98	0.78	0.90	0.97	1.01	0.98
TWC/Carb or MI	1.19	1.10	1.15	0.97	0.83*	0.87
TWC/FI	0.75	0.37	0.65	0.98	0.95	2.48
Bag 3						
No Cat/Carb	0.63	0.42		1.00		
Oxy Cat/Carb	1.13	0.83**	0.85	1.00	0.87	1.04
TWC/Carb or MI	1.00	0.82*	1.09	0.98*	1.01	1.27*
TWC/FI	0.95	0.57*	0.66	1.00	0.73*	1.39
Composite						
No Cat/Carb	0.76	0.65		1.01		
Oxy Cat/Carb	1.01	0.83	0.66	0.98	0.71	0.75
TWC/Carb or MI	1.03	0.94	1.02	0.97	0.86	1.03
TWC/FI	1.00	0.83	0.89	0.98	0.90	1.35

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.11 Analysis of FTP CO_2 emissions by vehicle technology

Average Test Fuel Ratio

Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	1.00	1.05		1.05		
Oxy Cat/Carb	1.02	1.00	0.84	0.98	0.82	0.83
TWC/Carb or MI	1.00	0.98	0.97	0.98	1.00	1.02
TWC/FI	0.99	0.98	0.94	0.99	0.95	0.94
Bag 2						
No Cat/Carb	1.01	1.01		1.00		
Oxy Cat/Carb	1.01	0.98	0.81	0.97	0.82	0.82
TWC/Carb or MI	1.01	0.98	0.96**	0.97	0.97	1.02
TWC/FI	1.00	0.98	0.92	0.98	0.91	0.93
Bag 3						
No Cat/Carb	1.00	1.00		1.00		
Oxy Cat/Carb	0.99	0.99	0.80	1.00	0.82	0.81
TWC/Carb or MI	1.01	0.98	0.96	0.98*	0.97	0.99
TWC/FI	1.00	1.00	0.94	1.00	0.94	0.94
Composite						
No Cat/Carb	1.01	1.01		1.01		
Oxy Cat/Carb	1.01	0.99	0.81	0.98	0.82	0.82
TWC/Carb or MI	1.01	0.98	0.96	0.97	0.97	1.01*
TWC/FI	1.00	0.98	0.93	0.98	0.93	0.93

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.12 Analysis of FTP NOX emissions by vehicle technology

Technology	Average Test Fuel Ratio Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	1.03	0.97		0.95		
Oxy Cat/Carb	0.97	0.98	1.00	1.01	1.08	1.11
TWC/Carb or MI	0.99	0.94	0.95	0.95	1.01	1.06
TWC/FI	1.03	0.84	0.96	0.81***	0.94	1.14**
Bag 2						
No Cat/Carb	1.05	1.00		0.95		
Oxy Cat/Carb	0.92	1.03	1.06	1.12	1.11	1.04
TWC/Carb or MI	1.03	0.88**	0.91****	0.85	0.86	1.07
TWC/FI	1.17*	0.99	1.09	0.84**	0.96	1.11
Bag 3						
No Cat/Carb	1.03	0.88		0.86		
Oxy Cat/Carb	0.94	0.94	0.99	1.00	1.15	1.25
TWC/Carb or MI	0.98	0.85	0.91	0.86	0.97	1.18
TWC/FI	0.95	0.90	0.92	0.94	1.02	1.01
Composite						
No Cat/Carb	1.03	0.95		0.92		
Oxy Cat/Carb	0.93	0.99	1.03	1.06	1.12	1.12
TWC/Carb or MI	1.00	0.90	0.93**	0.89	0.95	1.09
TWC/FI	1.07	0.92	1.01	0.86*	0.98	1.09

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.13 Analysis of FTP exhaust benzene emissions by vehicle technology

Technology	Average Test Fuel Ratio Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	1.69	1.26		0.74		
Oxy Cat/Carb	0.95	0.62**	0.74	0.65*	0.80	1.18
TWC/Carb or MI	1.06	0.64****	0.75	0.60***	0.66	1.16
TWC/FI	0.95	0.62**	0.72**	0.65*	0.74***	1.31**
Bag 2						
No Cat/Carb	0.87	0.69		0.79		
Oxy Cat/Carb	0.98	0.82	0.97	0.83*	1.02	1.24
TWC/Carb or MI	1.16	0.87	0.62	0.75	0.47	0.57
TWC/FI	0.85	0.53	0.64	0.62**	0.95	1.17
Bag 3						
No Cat/Carb	0.93	0.57		0.61		
Oxy Cat/Carb	0.98	0.68**	0.79	0.70	0.91	1.17
TWC/Carb or MI	1.07	0.62****	0.78***	0.58***	0.70	1.30**
TWC/FI	0.93	0.41**	0.62	0.44***	0.71	1.75
Composite						
No Cat/Carb	1.03	0.75		0.73		
Oxy Cat/Carb	0.98	0.69**	0.85	0.71	0.92	1.21
TWC/Carb or MI	1.07	0.66***	0.74	0.62***	0.65	1.11
TWC/FI	0.91	0.54*	0.66**	0.59**	0.75***	1.40*

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.14 Analysis of FTP exhaust 1,3-butadiene emissions by vehicle technology

	Average Test Fuel Ratio					
Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	1.52	1.56		1.02		
Oxy Cat/Carb	0.86	0.77	0.85	0.89	1.06	1.17
TWC/Carb or MI	1.01	0.66****	0.79	0.65**	0.76	1.25
TWC/FI	0.99	0.79	0.86	0.80**	0.88	1.12
Bag 2						
No Cat/Carb	0.98	0.92		0.95		
Oxy Cat/Carb	1.07*	1.12	1.26	1.05	1.19	1.15
TWC/Carb or MI	0.93	0.59	0.82	0.55	0.81	1.70
TWC/FI						
Bag 3						
No Cat/Carb	0.86	0.95		1.10		
Oxy Cat/Carb	1.04	0.95	1.06	0.92	1.21	1.17
TWC/Carb or MI	1.04	0.61**	0.89	0.59	0.84	1.63
TWC/FI	1.12	0.91	0.83	0.82*	1.00	1.00
Composite						
No Cat/Carb	1.04	1.03		1.00		
Oxy Cat/Carb	0.97	0.91	1.07	0.94	1.16	1.16
TWC/Carb or MI	1.00	0.61***	0.71	0.61***	0.67	1.26
TWC/FI	1.02	0.79	0.82	0.79**	0.89	1.14

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.15 Analysis of FTP exhaust formaldehyde emissions by vehicle technology

Technology	Average Test Fuel Ratio					
	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Bag 1						
No Cat/Carb	1.02	1.23		1.21		
Oxy Cat/Carb	0.81	1.09	0.92	1.34	1.24	1.09
TWC/Carb or MI	1.10	1.31**	1.31***	1.19	1.26	0.91
TWC/FI	1.08	1.51	0.96	1.40**	1.02	0.76
Bag 2						
No Cat/Carb	1.06	1.33		1.26		
Oxy Cat/Carb	0.87	1.31	1.16	1.50	1.30	1.03
TWC/Carb or MI	1.04	1.17	1.18	1.12	1.19	1.11
TWC/FI	0.89	1.36	1.44	1.53	1.04	1.22
Bag 3						
No Cat/Carb	1.10	1.44		1.31		
Oxy Cat/Carb	0.92	1.11	0.97	1.22	1.16	1.10
TWC/Carb or MI	1.05	1.41**	1.03	1.34	1.15	0.75
TWC/FI	1.27	1.23	1.14	0.97	1.08	1.05
Composite						
No Cat/Carb	1.06	1.34		1.26		
Oxy Cat/Carb	0.87	1.21	1.06	1.38	1.25	1.06
TWC/Carb or MI	1.07	1.27*	1.28*	1.18	1.29	1.06
TWC/FI	1.11	1.43*	1.04	1.29*	1.02	0.83

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.16 Analysis of FTP exhaust acetaldehyde emissions by vehicle technology

Average Test Fuel Ratio

Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Phase 1						
No Cat/Carb	1.06	1.17		1.10		
Oxy Cat/Carb	0.88	1.00	1.39	1.15	1.73	1.59
TWC/Carb or MI	1.04	0.88**	1.99*	0.85**	1.93	2.34*
TWC/FI	1.06	1.12	1.83***	1.06	1.90**	1.87***
Phase 2						
No Cat/Carb	1.10	1.28		1.16		
Oxy Cat/Carb	0.93**	1.23*	1.67	1.32**	1.79	1.38
TWC/Carb or MI	1.01	0.74	2.11**	0.73	2.26*	3.49
TWC/FI	0.82	0.62	0.69	0.76	0.69	1.26
Phase 3						
No Cat/Carb	1.28	1.52		1.19		
Oxy Cat/Carb	1.02	1.12	1.58	1.10**	1.61	1.47
TWC/Carb or MI	1.04	0.80	1.94	0.77**	2.20****	2.93**
TWC/FI	1.33	0.78	0.96	0.59*	0.80	1.44
Composite						
No Cat/Carb	1.14	1.32		1.16		
Oxy Cat/Carb	0.95	1.15	1.59	1.22**	1.74	1.44
TWC/Carb or MI	1.06	0.79	1.98*	0.74**	1.98	3.01
TWC/FI	1.01	0.95	1.63***	0.93	1.67*	1.86**

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.17 Fuel Ratios for Evaporative HC Running Loss

Fuel Ratio	Total	Phase 1HC	Phase 2HC	Phase 3HC
Phase 1/Base	0.7682	0.8577	0.8838	0.7414
Phase 2/Base	0.7260	0.8604	0.7728*	0.6218*
SBE/Base	2.1413	0.8904	1.6078	2.7832
Phase 2/Phase 1	0.9451	1.0139	0.8743	0.8387
SBE/Phase 1	2.4967	1.2063	1.7873	2.8456
SBE/Phase 2	2.5269	1.0449	1.9985**	3.8701

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.18 Fuel Ratios for Evaporative Emissions

Fuel Ratio	Hot Soak HC	VT Day 1 HC	VT Day 2 HC	VT Day 3 HC
Phase 1/Base	0.4017	0.6943**	0.6057***	0.7290****
Phase 2/Base	0.2999*	0.5187***	0.4069***	0.4354****
SBE/Base	1.1010	0.7283	0.5903*	0.6799*
Phase 2/Phase 1	0.7467	0.7471	0.6718**	0.5973***
SBE/Phase 1	5.1940*	1.2216	1.1513	0.9888
SBE/Phase 2	8.7628*	1.8349**	1.8974**	1.6488***

NOTE: P-values for testing differences between fuels are denoted by * $p<0.1$, ** $p<0.05$, *** $p<0.01$ & **** $p<0.001$

Table H.19 Fuel Ratios for Evaporative Running Loss benzene Emissions

Fuel Ratio	benzene
Phase 1/Base	0.9976
Phase 2/Base	0.9977
SBE/Base	0.9999
Phase 2/Phase 1	1.0002
SBE/Phase 1	1.0032
SBE/Phase 2	1.0017

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.20 Analysis of Running Loss evaporative HC emissions by vehicle technology

	Average Test Fuel Ratio					
Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Phase 1						
Post 80/Carb,MI/CL	0.54	0.48	0.35	0.90	1.00	1.31
Post 80/FI/CL	0.96	1.31	1.21	1.36	1.33	0.81
Post 80/FI/OP	0.64	0.53	0.84	0.83	1.31	1.58
Pre 80/Carb/CL	1.52	0.95		0.63		
Pre 80/Carb/OP	1.00	0.87	0.93	0.87	0.78	0.93
Phase 2						
Post 80/Carb,MI/CL	0.70	0.60	0.99	0.86	1.76	2.41
Post 80/FI/CL	0.83	0.55	1.56	0.66	1.28*	2.08
Post 80/FI/OP	0.76	0.91	1.21	1.19	1.58	1.32
Pre 80/Carb/CL	1.55	1.14		0.74		
Pre 80/Carb/OP	0.93	0.89	1.04	0.96	0.98	0.90
Phase 3						
Post 80/Carb,MI/CL	0.71	0.57	1.11	0.81	1.82	2.57
Post 80/FI/CL	0.49	0.29	1.65	0.59	1.15	2.60
Post 80/FI/OP	0.68	0.76	0.66	1.12	0.96	0.86
Pre 80/Carb/CL	1.55	1.45		0.93		
Pre 80/Carb/OP	0.88	0.85	1.24	0.96	1.20	1.20
TOTAL						
Post 80/Carb,MI/CL	0.66	0.56	0.83	0.85	1.62	2.23
Post 80/FI/CL	0.55	0.53	1.41	0.95	1.26	1.30
Post 80/FI/OP	0.69	0.72	0.90	1.04	1.30	1.25
Pre 80/Carb/CL	1.53	1.13		0.74		
Pre 80/Carb/OP	0.94	0.88	1.09	0.93	1.00	1.02

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.21 Analysis of evaporative VT HC emissions by vehicle technology

	Average Test Fuel Ratio					
Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
DAY 1						
Post 80/Carb,MI/CL	0.55	0.76	0.67	1.40	2.11	0.95
Post 80/FI/CL	0.87	0.50**	0.82	0.58	1.00	1.81*
Post 80/FI/OP	0.26	0.23	0.40	0.88	1.52	1.73
Pre 80/Carb/CL	0.78	0.47		0.61		
Pre 80/Carb/OP	0.73	0.40	0.58	0.55*	1.01	1.93
DAY 2						
Post 80/Carb,MI/CL	0.58	0.65	0.86	1.12	2.01	1.20
Post 80/FI/CL	0.41	0.21**	0.41	0.52**	1.06	1.84*
Post 80/FI/OP	0.35	0.10	0.37	0.28	1.03	3.63
Pre 80/Carb/CL	0.90	0.65		0.72		
Pre 80/Carb/OP	0.82	0.63	0.70	0.77**	0.99	1.27
DAY 3						
Post 80/Carb,MI/CL	0.61	0.44	0.85	0.72	1.78	1.24
Post 80/FI/CL	0.66*	0.25**	0.49	0.38**	0.70	1.73**
Post 80/FI/OP	0.60	0.27	0.58	0.44	0.97	2.19
Pre 80/Carb/CL	0.91	0.66		0.72		
Pre 80/Carb/OP	0.82	0.67	0.80	0.81**	1.06	1.29

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.22 Analysis of evaporative Hot Soak HC emissions by vehicle technology

	Average Test Fuel Ratio					
Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Post 80/Carb,MI/CL	1.70	1.36	1.06	0.80	0.95	0.66
Post 80/FI/CL	0.04**	0.03**	1.47	0.78	52.28**	68.68**
Post 80/FI/OP	0.04	0.04	0.05	1.05	1.33	1.26
Pre 80/Carb/CL	1.05	1.84		1.76		
Pre 80/Carb/OP	0.58	0.89	0.48	1.52	2.95	1.77

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Table H.23 Analysis of Running Loss evaporative benzene emissions by vehicle technology

	Average Test Fuel Ratio					
Technology	Phase 1 /Base	Phase 2 /Base	SBE /Base	Phase 2 /Phase 1	SBE /Phase 1	SBE /Phase 2
Post 80/Carb,MI/CL	0.55	0.66**	0.67	1.21	2.00	1.00
Post 80/FI/CL	0.95	0.36	0.85	0.58	0.89	1.55
Post 80/FI/OP						
Pre 80/Carb/CL	1.02	0.44		0.43		
Pre 80/Carb/OP	0.92	0.65	0.67	0.71***	0.71	0.71

NOTE: P-values for testing differences between fuels are denoted by * p<0.1, ** p<0.05, *** p<0.01 & **** p<0.001

Appendix I Mass Emissions

- FTP
- Running Loss
- Hot Soak
- Hourly VT SHED

Table 1.1 FTP Bag 1 Mass Emissions Results

Vehicle	Fuel	HC, g/mile	CO, g/mile	NO_x, g/mile	CO_2, g/mile
1	Base	0.739	4.378	0.601	410.4
1	Phase 1	0.803	5.846	0.562	408.7
1	Phase 2	0.555	3.306	0.462	408.4
1	SBE	0.673	5.673	0.525	411.0
2	Base	2.116	29.504	4.934	483.4
2	Phase 1	2.276	33.183	4.279	463.1
2	Phase 2	2.059	29.825	4.675	465.9
2	SBE	2.215	29.445	4.574	479.7
3	Base	2.780	40.242	3.831	622.1
3	Phase 1	2.846	34.767	3.935	619.4
3	Phase 2	3.067	35.090	3.734	651.3
5	Base	0.708	9.861	0.797	336.3
5	Phase 1	0.673	8.926	0.943	338.9
5	Phase 2	0.562	6.624	0.756	336.4
5	SBE	0.606	7.237	0.830	278.9
5	SBE	0.598	6.627	0.831	328.9
7	Base	1.401	13.957	2.698	359.5
7	Phase 1	1.468	13.439	2.720	362.5
7	Phase 2	1.215	13.153	2.607	362.5
8	Base	0.890	10.626	1.182	325.9
8	Phase 1	0.883	11.224	1.256	319.2
8	Phase 2	1.516	22.309	0.943	299.0
8	Phase 2-R	1.284	16.879	1.064	325.6
9	Base	1.024	13.524	0.597	392.0
9	Phase 1	0.921	17.557	0.599	390.4
9	Phase 2	0.808	12.691	0.506	374.0
9	SBE	0.814	12.814	0.576	375.3
10	Base	2.840	37.743	1.714	599.3
10	Phase 1	2.958	35.863	1.755	608.1
10	Phase 1-R	3.266	43.227	1.775	609.8
10	Phase 2	2.987	28.535	1.822	594.0
11	Base	2.173	39.166	2.420	518.7
11	Base	1.565	25.583	2.486	536.1
11	Phase 1	1.740	26.814	2.638	542.8
11	Phase 2	2.019	38.056	2.431	524.0
12	Base	2.067	41.298	1.016	392.5
12	Phase 1	2.164	39.879	0.942	403.6
12	Phase 2	1.842	36.897	0.921	399.4
12	SBE	1.941	12.234	1.021	331.5
13a	Base	0.936	8.873	0.949	388.8
13a	Phase 1	0.911	8.668	0.891	375.2
13a	Phase 2	0.862	9.539	0.764	389.5
13a	SBE	1.033	9.606	0.902	389.8

Table 1.2 FTP Bag 2 Mass Emissions Results

Vehicle	Fuel	HC, g/mile	CO, g/mile	NOx, g/mile	CO2, g/mile
1	Base	0.020	0.174	0.369	456.8
1	Phase 1	0.019	0.141	0.477	455.9
1	Phase 2	0.018	0.030	0.411	444.7
1	SBE	0.021	0.165	0.532	442.4
2	Base	1.256	7.741	3.477	480.4
2	Phase 1	1.234	7.974	3.267	468.2
2	Phase 2	0.754	6.691	3.143	461.7
2	SBE	1.241	6.790	3.167	462.6
3	Base	2.026	18.320	2.301	714.9
3	Phase 1	1.725	13.788	2.410	723.3
3	Phase 2	1.874	11.239	2.301	722.3
5	Base	0.046	1.873	0.308	363.2
5	Phase1	0.033	1.407	0.350	375.5
5	Phase2	0.024	0.361	0.286	359.1
5	SBE	0.034	1.112	0.247	295.7
5	SBE-R	0.024	0.484	0.229	357.0
7	Base	0.909	8.511	1.697	329.2
7	Phase1	0.958	8.784	1.794	335.5
7	Phase2	0.887	8.151	1.596	331.4
8	Base	0.217	1.674	0.845	360.7
8	Phase1	0.260	1.676	1.084	356.6
8	Phase2	0.135	1.781	0.839	346.5
8	Phase2-R	0.301	2.000	0.961	366.9
9	Base	0.041	1.307	0.109	400.7
9	Phase1	0.059	2.439	0.129	403.9
9	Phase2	0.081	2.673	0.087	371.4
9	SBE	0.044	1.980	0.099	383.4
10	Base	1.104	1.279	1.859	612.5
10	Phase1	1.041	1.380	1.655	640.5
10	Phase1-R	1.100	1.782	1.517	652.9
10	Phase2	1.341	0.861	1.925	600.8
11	Base	0.638	7.044	0.939	581.9
11	Base-R	0.590	7.085	0.856	590.6
11	Phase1	0.616	7.150	0.916	595.0
11	Phase2	0.560	6.180	0.835	586.9
12	Base	0.945	17.644	0.874	440.8
12	Phase1	0.980	15.619	0.836	432.1
12	Phase2	1.292	16.113	0.895	433.8
12	SBE	1.348	15.805	0.927	354.9
13	Base	0.037	0.529	0.351	439.5
13	Phase1	0.034	0.272	0.350	438.3
13	Phase2	0.030	0.281	0.325	441.1
13	SBE	0.031	0.253	0.397	430.0

Table I.3 FTP Bag 3 Mass Emissions Results

Vehicle	Fuel	HC, g/mile	CO, g/mile	NOx, g/mile	CO2, g/mile
1	Base	0.062	1.302	0.442	393.1
1	Phase 1	0.060	1.107	0.418	375.2
1	Phase 2	0.041	0.505	0.307	367.0
1	SBE	0.061	0.972	0.425	392.8
2	Base	1.264	8.262	4.839	420.1
2	Phase 1	1.267	8.222	4.532	412.6
2	Phase 2	0.958	7.161	4.526	409.8
2	SBE	1.251	9.298	4.483	411.5
3	Base	2.442	22.867	4.151	620.8
3	Phase 1	2.267	14.292	4.255	621.6
3	Phase 2	2.078	9.524	3.642	619.5
5	Base	0.063	2.868	0.511	300.0
5	Phase1	0.048	2.023	0.402	306.5
5	Phase2	0.037	1.146	0.432	306.0
5	SBE	0.051	1.290	0.387	245.8
5	SBE	0.047	1.166	0.484	293.8
7	Base	1.015	11.448	2.945	297.0
7	Phase1	1.057	10.582	3.085	304.6
7	Phase2	0.880	7.045	2.891	293.1
8	Base	0.304	2.684	1.206	290.5
8	Phase1	0.345	2.926	1.394	292.2
8	Phase2	0.292	2.700	1.075	282.5
8	Phase2	0.350	4.207	1.180	302.5
9	Base	0.209	7.238	0.243	360.5
9	Phase1	0.222	8.411	0.228	362.9
9	Phase2	0.168	6.075	0.152	349.3
9	SBE	0.175	7.582	0.215	340.6
10	Base	1.745	15.483	1.621	548.4
10	Phase1	1.815	20.441	1.645	554.9
10	Phase1	2.004	23.087	1.578	572.2
10	Phase2	1.909	12.944	1.779	545.0
11	Base	0.992	13.285	1.738	479.8
11	Base	0.862	11.967	1.729	490.4
11	Phase1	0.966	12.602	1.773	487.7
11	Phase2	0.865	12.255	1.588	481.4
12	Base	1.162	19.811	1.337	352.1
12	Phase1	1.264	19.235	1.157	343.7
12	Phase2	1.330	16.179	1.066	348.9
12	SBE	1.402	16.764	1.328	281.9
13	Base	0.243	2.613	0.523	343.8
13	Phase1	0.217	3.226	0.503	349.8
13	Phase2	0.176	1.808	0.655	364.3
13	SBE	0.188	2.229	0.552	348.8

Table I.4 FTP Composite Mass Emissions Results

Vehicle	Fuel	HC, g/mile	CO, g/mile	NOx, g/mile	CO2, g/mile
1	Base	0.181	1.357	0.437	429.6
1	Phase 1	0.193	1.590	0.479	423.9
1	Phase 2	0.135	0.839	0.393	415.8
1	SBE	0.167	1.529	0.501	422.3
2	Base	1.436	12.392	4.153	464.5
2	Phase 1	1.459	13.260	3.824	451.9
2	Phase 2	1.081	11.624	3.841	448.3
2	SBE	1.446	12.181	3.821	452.1
3	Base	2.296	24.107	3.125	669.9
3	Phase 1	2.106	18.279	3.232	673.8
3	Phase 2	2.177	15.708	2.964	679.5
5	Base	0.188	3.801	0.465	340.3
5	Phase1	0.170	3.136	0.487	349.0
5	Phase2	0.139	1.874	0.424	339.8
5	SBE	0.157	2.430	0.406	278.5
5	SBE-R	0.149	1.946	0.424	333.8
7	Base	1.040	10.448	2.248	326.7
7	Phase1	1.091	10.243	2.341	332.6
7	Phase2	0.953	9.050	2.161	327.3
8	Base	0.381	3.811	1.015	334.2
8	Phase1	0.413	4.000	1.205	331.1
8	Phase2	0.465	6.294	0.926	319.0
8	Phase2-R	0.518	5.691	1.042	340.6
9	Base	0.290	5.459	0.247	387.9
9	Phase1	0.282	7.210	0.254	389.8
9	Phase2	0.255	5.681	0.192	365.9
9	SBE	0.240	5.764	0.230	370.0
10	Base	1.638	12.699	1.764	592.2
10	Phase1	1.650	13.733	1.673	610.4
10	Phase1-R	1.797	16.220	1.587	621.8
10	Phase2	1.837	9.893	1.864	584.1
11	Base	1.052	15.390	1.464	540.9
11	Base-R	0.867	12.261	1.434	551.7
11	Phase1	0.945	12.719	1.508	554.7
11	Phase2	0.946	14.453	1.373	544.9
12	Base	1.237	23.144	1.031	406.5
12	Phase1	1.303	21.632	0.946	402.0
12	Phase2	1.416	20.486	0.947	403.4
12	SBE	1.486	15.327	1.057	330.0
13	Base	0.280	2.832	0.522	402.7
13	Phase1	0.266	2.825	0.504	400.9
13	Phase2	0.243	2.625	0.507	409.3
13	SBE	0.282	2.738	0.545	399.3

Table I.5 Running Loss HC Data by Phase

Veh#	Fuel#	Test Date	g/mile Phase 1	Phase 2	Phase 3	Total
01	Base	5/17/93	0.031	0.038	0.031	0.034
01	Phase 1	5/27/93	0.037	0.034	0.039	0.036
01	Phase 2	7/16/93	0.034	0.034	0.026	0.031
01	SBE	6/17/93	0.043	0.045	0.039	0.042
02	Base	5/24/93	5.197	6.472	5.107	5.592
02	Phase 1	6/3/93	1.818	3.630	3.124	2.857
02	Phase 2	6/14/93	1.388	2.650	2.215	2.084
02	SBE	5/13/93	1.818	6.397	5.686	4.638
03	Base	12/16/93	0.370	0.347	0.313	0.343
03	Phase 1	12/7/93	0.312	0.286	0.237	0.279
03	Phase 2	11/18/93	0.282	0.242	0.218	0.247
05	Base	6/28/93	0.045	0.034	0.038	0.039
05	Phase 1	7/29/93	0.029	0.026	0.026	0.027
05	Phase 2	7/22/93	0.024	0.031	0.029	0.028
05	SBE	6/22/93	0.038	0.041	0.025	0.035
07	Base	11/1/93	0.113	0.089	0.102	0.101
07	Phase 1	10/25/93	0.114	0.099	0.081	0.098
07	Phase 2	11/9/93	0.102	0.092	0.088	0.094
08	Base-R	3/17/94	0.018	0.027	0.035	0.027
08	Base	8/23/93	0.034	0.108	0.741	0.294
08	Phase 1	9/9/93	0.037	0.042	0.041	0.040
08	Phase 2	9/27/93	0.034	0.032	0.044	0.037
09	Base	8/16/93	0.040	0.042	0.037	0.040
09	Phase 1	7/19/93	0.029	0.033	0.036	0.033
09	Phase 2	9/30/93	0.047	0.047	0.037	0.044
09	SBE	10/7/93	0.049	0.240	6.917	2.402
10	Base	10/28/93	0.124	0.076	0.067	0.089
10	Phase 1	10/21/93	0.188	0.118	0.104	0.136
10	Phase 2	10/4/93	0.118	0.087	0.097	0.101
11	Base	12/27/93	0.133	0.113	0.113	0.120
11	Phase 1	1/25/94	0.110	0.099	0.093	0.101
11	Phase 2	1/7/93	0.116	0.100	0.085	0.100
12	Base	10/12/93	0.055	0.055	0.062	0.057
12	Phase 1	8/12/93	0.065	0.058	0.064	0.062
12	Phase 2	8/19/93	0.055	0.063	0.064	0.061
12	SBE	8/5/93	0.051	0.057	0.077	0.062
13	Base	12/20/93	0.055	0.030	0.029	0.038
13	Phase 1	12/13/93	0.038	0.050	0.048	0.045
13	Phase 2	11/29/93	0.113	0.019	0.014	0.049
13	SBE	1/3/94	0.058	0.062	0.063	0.061

Table I.6 Hot Soak Test Results

Vehicle	Fuel	Hot Soak, g/test
01	Base	16.49
01	Phase 1	0.47
01	Phase 2	0.45
01	SBE	22.63
02	Base	7.32
02	Phase 1	8.17
02	Phase 2	11.74
02	SBE	7.75
03	Base	5.25
03	Phase 1	10.88
03	Phase 2	15.11
05	Base	9.16
05	Phase 1	0.34
05	Phase 2	0.36
05	SBE	0.46
07	Base	1.64
07	Phase 1	1.33
07	Phase 2	1.41
08	Base	4.26
08	Phase 1	0.45
08	Phase 2	0.36
09	Base	0.97
09	Phase 1	16.31
09	Phase 2	0.49
09	SBE	31.52
10	Base	8.31
10	Phase 1	8.73
10	Phase 2	15.32
11	Base	1.76
11	Phase 1	4.54
11	Phase 2	2.01
12	Base	9.12
12	Phase 1	1.50
12	Phase 2	2.49
12	SBE	4.41
13a	Base	25.06
13a	Phase 1	0.70
13a	Phase 2	0.42
13a	SBE	39.30

Appendix I (cont.) Mass Emissions

Hourly VT SHED HC Data [Tables I.7 - I.47]

Test Date: 5/17/93
Test Fuel: Base
Vehicle: 1

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.4	-1.6	--	--
1	66.6	66.2	-0.4	0.09	0.09
2	72.6	72.3	-0.3	0.10	0.19
3	80.3	78.5	-1.8	0.13	0.32
4	86.1	84.3	-1.8	0.17	0.48
5	90.6	88.9	-1.7	0.20	0.69
6	94.6	92.9	-1.7	0.24	0.93
7	98.1	97.1	-1.0	0.33	1.25
8	101.2	100.0	-1.2	0.46	1.71
9	103.4	102.8	-0.6	0.68	2.38
10	104.9	104.4	-0.5	0.82	3.21
11	105.0	104.5	-0.5	0.78	3.99
12	104.2	103.8	-0.4	0.30	4.29
13	101.1	101.1	0.0	0.24	4.53
14	95.3	95.7	0.4	0.21	4.74
15	88.8	89.0	0.2	0.09	4.83
16	84.4	85.3	0.9	0.10	4.93
17	80.8	82.0	1.2	0.07	5.00
18	77.8	78.4	0.6	0.02	5.02
19	75.3	75.5	0.2	0.07	5.08
20	72.0	73.4	1.4	0.06	5.14
21	70.0	70.1	0.1	0.00	5.14
22	68.2	70.9	2.7	0.04	5.18
23	66.5	66.9	0.4	0.03	5.21
24	65.0	66.0	1.0	-0.02	5.19
25	66.6	66.7	0.1	0.04	5.23
26	72.6	72.6	0.0	0.18	5.41
27	80.3	78.9	-1.4	0.41	5.81
28	86.1	84.8	-1.3	0.60	6.41
29	90.6	89.2	-1.4	0.70	7.11
30	94.6	93.4	-1.2	0.88	7.99
31	98.1	97.5	-0.6	1.36	9.35
32	101.2	100.6	-0.6	1.76	11.11
33	103.4	103.1	-0.3	1.95	13.06
34	104.9	104.5	-0.4	1.57	14.63
35	105.0	104.8	-0.2	1.35	15.98
36	104.2	104.2	0.0	0.53	16.52

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	101	-0.1	0.25	16.77
38	95.3	96	0.7	0.13	16.90
39	88.8	90.1	1.3	0.06	16.96
40	84.4	84.5	0.1	-0.03	16.93
41	80.8	80.9	0.1	0.00	16.93
42	77.8	80.2	2.4	0.00	16.93
43	75.3	75.7	0.4	-0.06	16.86
44	72	72.3	0.3	-0.06	16.80
45	70	70.2	0.2	-0.06	16.74
46	68.2	68.5	0.3	0.00	16.74
47	66.5	67.2	0.7	-0.06	16.68
48	65	66.4	1.4	-0.03	16.64
49	66.6	66.7	0.1	-0.03	16.61
50	72.6	72	-0.6	0.22	16.83
51	80.3	78.9	-1.4	0.50	17.34
52	86.1	85	-1.1	0.69	18.03
53	90.6	89.5	-1.1	0.85	18.88
54	94.6	93.3	-1.3	0.98	19.85
55	98.1	97.5	-0.6	1.54	21.39
56	101.2	100.2	-1	1.82	23.22
57	103.4	103	-0.4	1.89	25.10
58	104.9	104.4	-0.5	2.58	27.68
59	105	104.3	-0.7	1.38	29.07
60	104.2	104.2	0	0.41	29.48
61	101.1	102.3	1.2	0.10	29.57
62	95.3	96.4	1.1	0.19	29.76
63	88.8	90	1.2	0.00	29.76
64	84.4	84.3	-0.1	-0.09	29.67
65	80.8	81.7	0.9	-0.09	29.57
66	77.8	77.9	0.1	-0.09	29.48
67	75.3	75.9	0.6	0.00	29.48
68	72	73.5	1.5	-0.09	29.39
69	70	72.2	2.2	0.00	29.39
70	68.2	71.2	3	-0.09	29.29
71	66.5	69.4	2.9	0.00	29.29
72	65	68	3	0.00	29.29

Average Temperature Error (°F): 0.07

Automotive Testing Laboratories, Inc.

Test Date: 5/28/93
Test Fuel: Phase 1
Vehicle: 1

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.5	-0.5	--	--
1	66.6	66.7	0.1	0.22	0.22
2	72.6	72.4	-0.2	0.18	0.40
3	80.3	78.7	-1.6	0.21	0.60
4	86.1	84.8	-1.3	0.24	0.84
5	90.6	89.4	-1.2	0.27	1.11
6	94.6	93.4	-1.2	0.29	1.40
7	98.1	97.6	-0.5	0.32	1.73
8	101.2	100.6	-0.6	0.35	2.08
9	103.4	102.8	-0.6	0.38	2.45
10	104.9	104.5	-0.4	0.37	2.82
11	105.0	104.5	-0.5	0.39	3.21
12	104.2	104.2	0.0	0.33	3.54
13	101.1	101.6	0.5	0.29	3.83
14	95.3	95.2	-0.1	0.18	4.01
15	88.8	89.0	0.2	0.10	4.11
16	84.4	84.8	0.4	0.06	4.17
17	80.8	81.4	0.6	0.05	4.22
18	77.8	78.3	0.5	0.02	4.24
19	75.3	75.9	0.6	0.03	4.27
20	72.0	73.4	1.4	0.00	4.27
21	70.0	70.8	0.8	0.02	4.28
22	68.2	69.0	0.8	-0.01	4.27
23	66.5	67.6	1.1	0.01	4.28
24	65.0	66.4	1.4	0.01	4.29
25	66.6	66.8	0.2	0.02	4.31
26	72.6	72.6	0.0	0.13	4.44
27	80.3	79.2	-1.1	0.31	4.75
28	86.1	85.2	-0.9	0.42	5.18
29	90.6	89.6	-1.0	0.48	5.66
30	94.6	93.6	-1.0	0.54	6.20
31	98.1	97.8	-0.3	0.69	6.88
32	101.2	100.4	-0.8	0.81	7.69
33	103.4	102.7	-0.7	0.87	8.56
34	104.9	103.7	-1.2	0.67	9.23
35	105.0	105.0	0.0	1.13	10.36
36	104.2	104.0	-0.2	0.44	10.80

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	101.3	0.2	0.25	11.05
38	95.3	95.9	0.6	0.16	11.21
39	88.8	88.8	0	0.03	11.24
40	84.4	84.6	0.2	0.00	11.24
41	80.8	81.4	0.6	-0.09	11.14
42	77.8	78.1	0.3	-0.03	11.11
43	75.3	75.8	0.5	-0.03	11.08
44	72	73.5	1.5	-0.09	10.99
45	70	70.8	0.8	-0.09	10.89
46	68.2	69	0.8	-0.06	10.83
47	66.5	67.6	1.1	-0.03	10.80
48	65	66.4	1.4	-0.06	10.74
49	66.6	67.2	0.6	-0.03	10.70
50	72.6	71.9	-0.7	0.19	10.89
51	80.3	79	-1.3	0.53	11.43
52	86.1	85.2	-0.9	0.69	12.12
53	90.6	89.6	-1	0.82	12.93
54	94.6	93.6	-1	0.97	13.91
55	98.1	97.7	-0.4	1.29	15.20
56	101.2	100.6	-0.6	1.54	16.73
57	103.4	102.9	-0.5	1.70	18.43
58	104.9	104.6	-0.3	1.70	20.13
59	105	104.4	-0.6	1.13	21.26
60	104.2	104.3	0.1	0.57	21.82
61	101.1	101.1	0	0.25	22.07
62	95.3	95.4	0.1	0.13	22.20
63	88.8	89.1	0.3	-0.03	22.17
64	84.4	84.8	0.4	-0.06	22.10
65	80.8	81.7	0.9	-0.13	21.98
66	77.8	78.6	0.8	-0.06	21.92
67	75.3	76.2	0.9	-0.13	21.79
68	72	73.9	1.9	-0.06	21.73
69	70	71.4	1.4	-0.13	21.60
70	68.2	69.3	1.1	-0.16	21.44
71	66.5	67.8	1.3	-0.09	21.35
72	65	66.6	1.6	-0.06	21.29

Average Temperature Error (°F): 0.07

Automotive Testing Laboratories, Inc.

Test Date: 7/17/93
Test Fuel: Phase 2
Vehicle: 1

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.5	-1.5	--	--
1	66.6	65.8	-0.8	0.09	0.09
2	72.6	71.9	-0.7	0.07	0.17
3	80.3	79.7	-0.6	0.08	0.25
4	86.1	85.7	-0.4	0.11	0.36
5	90.6	90.5	-0.1	0.12	0.48
6	94.6	93.3	-1.3	0.15	0.63
7	98.1	97.2	-0.9	0.17	0.80
8	101.2	99.6	-1.6	0.20	1.00
9	103.4	102.5	-0.9	0.22	1.22
10	104.9	104.0	-0.9	0.22	1.44
11	105.0	104.7	-0.3	0.27	1.71
12	104.2	103.7	-0.5	0.25	1.96
13	101.1	100.0	-1.1	0.21	2.17
14	95.3	95.5	0.2	0.19	2.36
15	88.8	88.6	-0.2	0.16	2.52
16	84.4	84.8	0.4	0.08	2.60
17	80.8	81.1	0.3	0.06	2.66
18	77.8	78.1	0.3	0.05	2.71
19	75.3	75.1	-0.2	0.02	2.73
20	72.0	72.2	0.2	0.03	2.76
21	70.0	70.1	0.1	0.02	2.78
22	68.2	68.4	0.2	0.02	2.80
23	66.5	66.5	0.0	0.02	2.81
24	65.0	65.0	0.0	0.02	2.83
25	66.6	66.4	-0.2	0.05	2.88
26	72.6	72.0	-0.6	0.09	2.97
27	80.3	80.2	-0.1	0.16	3.13
28	86.1	85.8	-0.3	0.21	3.33
29	90.6	90.2	-0.4	0.24	3.57
30	94.6	93.4	-1.2	0.27	3.85
31	98.1	97.4	-0.7	0.30	4.15
32	101.2	99.8	-1.4	0.32	4.47
33	103.4	102.5	-0.9	0.44	4.91
34	104.9	104.0	-0.9	0.44	5.34
35	105.0	104.7	-0.3	0.40	5.74
36	104.2	103.8	-0.4	0.32	6.06

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	99.8	-1.3	0.25	6.31
38	95.3	95	-0.3	0.18	6.49
39	88.8	88.8	0	0.12	6.61
40	84.4	84.5	0.1	0.04	6.65
41	80.8	81	0.2	0.03	6.68
42	77.8	77.9	0.1	0.00	6.68
43	75.3	75.5	0.2	0.00	6.68
44	72	72.2	0.2	0.01	6.69
45	70	70.1	0.1	-0.03	6.66
46	68.2	68.2	0	0.00	6.66
47	66.5	66.7	0.2	-0.02	6.64
48	65	65.2	0.2	-0.01	6.63
49	66.6	66.6	0	0.02	6.65
50	72.6	71.9	-0.7	0.13	6.78
51	80.3	79.5	-0.8	0.27	7.05
52	86.1	85.2	-0.9	0.39	7.44
53	90.6	89.9	-0.7	0.45	7.90
54	94.6	93.3	-1.3	0.46	8.36
55	98.1	97.1	-1	0.60	8.96
56	101.2	99.6	-1.6	0.69	9.66
57	103.4	102.4	-1	0.66	10.32
58	104.9	103.7	-1.2	0.66	10.98
59	105	104.6	-0.4	0.63	11.61
60	104.2	103.7	-0.5	0.41	12.03
61	101.1	99.5	-1.6	0.28	12.31
62	95.3	95.4	0.1	0.16	12.47
63	88.8	88.9	0.1	0.06	12.53
64	84.4	84.5	0.1	0.03	12.56
65	80.8	80.8	0	0.00	12.56
66	77.8	78	0.2	-0.03	12.53
67	75.3	75.2	-0.1	-0.06	12.47
68	72	72	0	-0.03	12.44
69	70	70	0	-0.06	12.37
70	68.2	68.2	0	-0.03	12.34
71	66.5	66.6	0.1	-0.06	12.28
72	65	65.1	0.1	-0.03	12.25
Average Temperature Error (°F):			-0.40		

Automotive Testing Laboratories, Inc.

Test Date: 6/18/93
Test Fuel: SBE
Vehicle: 1

	SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.7	-0.3	--	--
1	66.6	66.6	0.0	0.23	0.23
2	72.6	72.8	0.2	0.21	0.45
3	80.3	79.2	-1.1	0.23	0.68
4	86.1	85.7	-0.4	0.29	0.97
5	90.6	89.9	-0.7	0.30	1.27
6	94.6	93.8	-0.8	0.35	1.62
7	98.1	97.9	-0.2	0.41	2.03
8	101.2	100.5	-0.7	0.44	2.47
9	103.4	102.1	-1.3	0.55	3.02
10	104.9	104.2	-0.7	0.55	3.57
11	105.0	104.3	-0.7	0.56	4.13
12	104.2	103.9	-0.3	0.40	4.52
13	101.1	101.8	0.7	0.31	4.84
14	95.3	95.1	-0.2	0.23	5.06
15	88.8	89.3	0.5	0.15	5.21
16	84.4	84.4	0.0	0.08	5.29
17	80.8	81.1	0.3	0.05	5.34
18	77.8	77.8	0.0	0.01	5.35
19	75.3	75.7	0.4	0.07	5.41
20	72.0	73.5	1.5	0.03	5.44
21	70.0	71.0	1.0	0.02	5.46
22	68.2	69.4	1.2	0.02	5.48
23	66.5	68.2	1.7	0.00	5.48
24	65.0	66.5	1.5	0.02	5.50
25	66.6	67.6	1.0	0.01	5.51
26	72.6	72.8	0.2	0.17	5.68
27	80.3	79.8	-0.5	0.35	6.03
28	86.1	85.7	-0.4	0.48	6.51
29	90.6	90.2	-0.4	0.57	7.08
30	94.6	94.0	-0.6	0.65	7.73
31	98.1	96.1	-2.0	0.80	8.53
32	101.2	100.6	-0.6	1.04	9.57
33	103.4	102.4	-1.0	1.17	10.74
34	104.9	103.0	-1.9	0.54	11.27
35	105.0	104.3	-0.7	1.17	12.44
36	104.2	103.9	-0.3	0.57	13.01

	SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative
37	101.1	101	-0.1	0.28	13.29
38	95.3	95.4	0.1	0.19	13.48
39	88.8	88.7	-0.1	0.03	13.51
40	84.4	84.4	0	0.06	13.58
41	80.8	81.2	0.4	-0.03	13.54
42	77.8	78	0.2	-0.06	13.48
43	75.3	75.6	0.3	-0.03	13.45
44	72	73.6	1.6	-0.03	13.42
45	70	71.1	1.1	-0.06	13.35
46	68.2	69.2	1	-0.06	13.29
47	66.5	67.8	1.3	-0.06	13.23
48	65	67.2	2.2	-0.03	13.20
49	66.6	66.7	0.1	-0.03	13.17
50	72.6	73.1	0.5	0.16	13.32
51	80.3	79.6	-0.7	0.44	13.77
52	86.1	85.5	-0.6	0.66	14.43
53	90.6	89.8	-0.8	0.76	15.19
54	94.6	93.7	-0.9	0.85	16.04
55	98.1	97.9	-0.2	1.20	17.24
56	101.2	100.4	-0.8	1.26	18.50
57	103.4	102.5	-0.9	1.64	20.14
58	104.9	104.7	-0.2	1.61	21.75
59	105	105.1	0.1	0.98	22.73
60	104.2	104.1	-0.1	0.50	23.23
61	101.1	101.4	0.3	0.25	23.48
62	95.3	97.3	2	0.16	23.64
63	88.8	88.5	-0.3	0.03	23.67
64	84.4	84.7	0.3	-0.06	23.61
65	80.8	81.2	0.4	-0.09	23.52
66	77.8	77.7	-0.1	-0.13	23.39
67	75.3	75.5	0.2	-0.13	23.26
68	72	73.2	1.2	-0.06	23.20
69	70	70.7	0.7	-0.16	23.04
70	68.2	69.2	1	-0.06	22.98
71	66.5	67.7	1.2	-0.09	22.88
72	65	67	2	-0.13	22.76
Average Temperature Error (°F):			0.09		

Automotive Testing Laboratories, Inc.

Test Date: 5/24/93
Test Fuel: Base
Vehicle: 2

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.6	-1.4	--	--
1	66.6	66.2	-0.4	1.31	1.31
2	72.6	72.9	0.3	2.21	3.52
3	80.3	78.3	-2.0	3.91	7.43
4	86.1	84.3	-1.8	5.88	13.32
5	90.6	88.8	-1.8	7.22	20.53
6	94.6	92.7	-1.9	7.60	28.13
7	98.1	96.9	-1.2	8.13	36.26
8	101.2	99.9	-1.3	8.63	44.90
9	103.4	102.5	-0.9	8.35	53.25
10	104.9	104.2	-0.7	8.06	61.31
11	105.0	104.2	-0.8	7.31	68.62
12	104.2	104.2	0.0	5.12	73.74
13	101.1	100.4	-0.7	2.85	76.59
14	95.3	94.7	-0.6	1.71	78.29
15	88.8	88.8	0.0	1.04	79.34
16	84.4	84.7	0.3	0.76	80.10
17	80.8	81.5	0.7	0.76	80.85
18	77.8	78.1	0.3	0.57	81.42
19	75.3	75.8	0.5	0.38	81.80
20	72.0	73.5	1.5	0.28	82.09
21	70.0	70.9	0.9	0.09	82.18
22	68.2	69.3	1.1	0.00	82.18
23	66.5	67.8	1.3	0.09	82.28
24	65.0	66.5	1.5	0.00	82.28
25	66.6	67.1	0.5	0.09	82.37
26	72.6	72.7	0.1	0.19	82.56
27	80.3	78.6	-1.7	1.80	84.37
28	86.1	84.8	-1.3	4.17	88.54
29	90.6	89.3	-1.3	5.20	93.74
30	94.6	93.1	-1.5	6.02	99.76
31	98.1	97.3	-0.8	6.97	106.73
32	101.2	98.8	-2.4	2.53	109.27
33	103.4	102.6	-0.8	7.60	116.87
34	104.9	104.8	-0.1	8.24	125.11
35	105.0	105.5	0.5	6.02	131.13
36	104.2	103.8	-0.4	4.44	135.57

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	101.5	0.4	2.53	138.10
38	95.3	95.3	0	0.95	139.05
39	88.8	89.3	0.5	0.32	139.37
40	84.4	84.7	0.3	0.32	139.68
41	80.8	81.4	0.6	0.00	139.68
42	77.8	78.4	0.6	-0.32	139.37
43	75.3	76	0.7	-0.32	139.05
44	72	73.6	1.6	0.00	139.05
45	70	71	1	-0.32	138.73
46	68.2	69.6	1.4	-0.63	138.10
47	66.5	67.9	1.4	0.00	138.10
48	65	66.6	1.6	0.00	138.10
49	66.6	67.2	0.6	-0.95	137.15
50	72.6	72.3	-0.3	0.00	137.15
51	80.3	78.6	-1.7	1.27	138.42
52	86.1	84.8	-1.3	3.80	142.22
53	90.6	89.3	-1.3	5.07	147.29
54	94.6	93.5	-1.1	5.39	152.68
55	98.1	97.3	-0.8	6.65	159.33
56	101.2	100.3	-0.9	6.97	166.30
57	103.4	102.7	-0.7	6.65	172.95
58	104.9	104.2	-0.7	6.34	179.29
59	105	104.3	-0.7	4.75	184.04
60	104.2	104	-0.2	4.12	188.16
61	101.1	101.5	0.4	1.90	190.06
62	95.3	95.5	0.2	0.32	190.38
63	88.8	89.1	0.3	0.63	191.01
64	84.4	84.7	0.3	-0.63	190.38
65	80.8	81.7	0.9	-0.32	190.06
66	77.8	78.3	0.5	-0.95	189.11
67	75.3	76	0.7	-0.32	188.80
68	72	73.7	1.7	-0.63	188.16
69	70	71.1	1.1	-0.32	187.84
70	68.2	69.4	1.2	-0.63	187.21
71	66.5	68.5	2	-0.63	186.58
72	65	66.7	1.7	-0.32	186.26

Average Temperature Error (°F): -0.06

Automotive Testing Laboratories, Inc.

Test Date: 3/15/94
Test Fuel: Phase 1
Vehicle: 2

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.0	-1.0	--	--
1	66.6	68.0	1.4	1.55	1.55
2	72.6	73.5	0.9	1.76	3.31
3	80.3	79.9	-0.4	3.22	6.53
4	86.1	85.7	-0.4	4.37	10.90
5	90.6	90.1	-0.5	5.55	16.45
6	94.6	94.1	-0.5	5.46	21.92
7	98.1	97.6	-0.5	5.65	27.56
8	101.2	100.7	-0.5	5.74	33.30
9	103.4	102.9	-0.5	4.92	38.22
10	104.9	104.4	-0.5	5.01	43.23
11	105.0	104.5	-0.5	3.92	47.14
12	104.2	103.6	-0.6	3.82	50.97
13	101.1	100.4	-0.7	2.00	52.97
14	95.3	95.3	0.0	1.55	54.52
15	88.8	88.4	-0.4	1.46	55.97
16	84.4	84.2	-0.2	0.18	56.16
17	80.8	80.7	-0.1	0.18	56.34
18	77.8	77.7	-0.1	0.46	56.79
19	75.3	75.1	-0.2	0.18	56.98
20	72.0	72.1	0.1	0.14	57.11
21	70.0	70.7	0.7	0.14	57.25
22	68.2	68.9	0.7	0.14	57.39
23	66.5	67.2	0.7	0.05	57.43
24	65.0	66.3	1.3	0.09	57.52
25	66.6	67.5	0.9	0.18	57.71
26	72.6	73.0	0.4	0.18	57.89
27	80.3	80.5	0.2	0.38	58.27
28	86.1	86.3	0.2	4.54	62.81
29	90.6	90.9	0.3	4.54	67.36
30	94.6	95.0	0.4	4.54	71.90
31	98.1	98.6	0.5	3.64	75.54
32	101.2	100.7	-0.5	2.42	77.96
33	103.4	102.1	-1.3	4.24	82.20
34	104.9	103.6	-1.3	4.24	86.45
35	105.0	103.7	-1.3	4.85	91.29
36	104.2	103.3	-0.9	0.91	92.20

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
37	101.1	100.4	-0.7	1.21	93.42
38	95.3	95.3	0	1.51	94.93
39	88.8	89	0.2	1.21	96.14
40	84.4	84.8	0.4	0.00	96.14
41	80.8	81.4	0.6	0.00	96.14
42	77.8	78.6	0.8	0.00	96.14
43	75.3	76.3	1	-0.61	95.54
44	72	73.2	1.2	-0.30	95.23
45	70	71.4	1.4	0.00	95.23
46	68.2	69.8	1.6	-0.30	94.93
47	66.5	68.3	1.8	-0.61	94.32
48	65	67	2	-0.61	93.72
49	66.6	67.2	0.6	0.00	93.72
50	72.6	73.6	1	0.00	93.72
51	80.3	81.25	0.95	0.30	94.02
52	86.1	87.05	0.95	2.73	96.75
53	90.6	91.5	0.9	3.03	99.78
54	94.6	95.45	0.85	3.94	103.72
55	98.1	98.9	0.8	4.54	108.26
56	101.2	101.95	0.75	0.91	109.17
57	103.4	104.1	0.7	7.57	116.75
58	104.9	105.55	0.65	1.21	117.96
59	105	105.6	0.6	0.61	118.56
60	104.2	104.75	0.55	8.48	127.05
61	101.1	101.6	0.5	2.42	129.47
62	95.3	95.75	0.45	0.61	130.08
63	88.8	89.2	0.4	0.00	130.08
64	84.4	84.75	0.35	0.00	130.08
65	80.8	81.1	0.3	0.00	130.08
66	77.8	78.05	0.25	0.00	130.08
67	75.3	75.5	0.2	0.00	130.08
68	72	72.15	0.15	-0.30	129.77
69	70	70.1	0.1	-0.30	129.47
70	68.2	68.25	0.05	-0.30	129.17
71	66.5	66.5	0	-0.30	128.87
72	65	66.2	1.2	-0.30	128.56

Average Temperature Error (°F): 0.26

Automotive Testing Laboratories, Inc.

Test Date: 6/4/93
Test Fuel: Phase 1
Vehicle: 2

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.1	-0.9	--	--
1	66.6	66.5	-0.1	0.56	0.56
2	72.6	72.5	-0.1	0.73	1.29
3	80.3	77.9	-2.4	1.27	2.56
4	86.1	84.2	-1.9	1.67	4.23
5	90.6	87.7	-2.9	0.77	5.00
6	94.6	92.9	-1.7	1.49	6.49
7	98.1	96.4	-1.7	1.85	8.34
8	101.2	100.8	-0.4	2.47	10.81
9	103.4	102.7	-0.7	3.75	14.56
10	104.9	103.5	-1.4	4.12	18.68
11	105.0	104.7	-0.3	2.28	20.97
12	104.2	103.8	-0.4	1.75	22.72
13	101.1	101.0	-0.1	0.53	23.25
14	95.3	95.6	0.3	0.22	23.47
15	88.8	89.5	0.7	0.12	23.59
16	84.4	85.1	0.7	0.06	23.65
17	80.8	81.8	1.0	0.06	23.72
18	77.8	78.7	0.9	0.03	23.75
19	75.3	76.2	0.9	0.03	23.78
20	72.0	73.9	1.9	0.19	23.97
21	70.0	71.5	1.5	0.37	24.34
22	68.2	69.0	0.8	0.53	24.87
23	66.5	67.4	0.9	0.69	25.56
24	65.0	66.1	1.1	0.78	26.34
25	66.6	67.0	0.4	0.72	27.06
26	72.6	71.1	-1.5	0.94	28.00
27	80.3	77.8	-2.5	1.31	29.31
28	86.1	84.6	-1.5	1.69	31.00
29	90.6	89.4	-1.2	1.40	32.40
30	94.6	93.1	-1.5	1.40	33.81
31	98.1	97.0	-1.1	1.59	35.40
32	101.2	100.1	-1.1	3.00	38.40
33	103.4	102.8	-0.6	3.47	41.86
34	104.9	103.9	-1.0	3.47	45.33
35	105.0	104.4	-0.6	2.34	47.67
36	104.2	104.1	-0.1	0.75	48.42

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	101.8	0.7	0.28	48.70
38	95.3	95.2	-0.1	0.09	48.79
39	88.8	90.2	1.4	-0.19	48.60
40	84.4	85.1	0.7	0.09	48.70
41	80.8	81.4	0.6	-0.09	48.60
42	77.8	77.6	-0.2	-0.19	48.42
43	75.3	75.2	-0.1	-0.09	48.32
44	72	72.6	0.6	0.00	48.32
45	70	70.2	0.2	0.28	48.60
46	68.2	68.5	0.3	0.56	49.17
47	66.5	66.6	0.1	0.56	49.73
48	65	65.5	0.5	0.56	50.29
49	66.6	66.9	0.3	0.75	51.04
50	72.6	71.2	-1.4	1.12	52.16
51	80.3	78	-2.3	1.40	53.57
52	86.1	84.8	-1.3	1.59	55.16
53	90.6	89.4	-1.2	1.40	56.57
54	94.6	93.3	-1.3	1.31	57.88
55	98.1	96.7	-1.4	1.87	59.75
56	101.2	100.4	-0.8	3.00	62.75
57	103.4	103	-0.4	3.75	66.49
58	104.9	104.1	-0.8	3.37	69.86
59	105	104.5	-0.5	2.25	72.11
60	104.2	104.3	0.1	0.94	73.05
61	101.1	101.4	0.3	0.37	73.42
62	95.3	96.9	1.6	0.00	73.42
63	88.8	91.2	2.4	-0.09	73.33
64	84.4	86.2	1.8	-0.28	73.05
65	80.8	81.7	0.9	-0.19	72.86
66	77.8	78.6	0.8	-0.28	72.58
67	75.3	76.4	1.1	-0.19	72.39
68	72	74.1	2.1	-0.09	72.30
69	70	71.1	1.1	0.00	72.30
70	68.2	68.8	0.6	0.19	72.49
71	66.5	67.5	1	0.37	72.86
72	65	66.6	1.6	0.47	73.33

Average Temperature Error (°F): -0.10

Automotive Testing Laboratories, Inc.

Test Date: 6/15/93

Test Fuel: Phase 2

Vehicle: 2

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	63.6	-1.4	--	--
1	66.6	66.7	0.1	1.35	1.35
2	72.6	71.1	-1.5	1.85	3.19
3	80.3	77.6	-2.7	2.48	5.67
4	86.1	84.2	-1.9	3.11	8.78
5	90.6	88.7	-1.9	4.35	13.12
6	94.6	92.7	-1.9	4.47	17.60
7	98.1	97.4	-0.7	4.88	22.48
8	101.2	99.7	-1.5	4.67	27.15
9	103.4	102.4	-1.0	4.06	31.21
10	104.9	103.9	-1.0	3.68	34.89
11	105.0	104.1	-0.9	2.74	37.63
12	104.2	103.3	-0.9	2.93	40.56
13	101.1	101.5	0.4	3.59	44.15
14	95.3	94.8	-0.5	2.46	46.60
15	88.8	88.7	-0.1	1.89	48.49
16	84.4	85.0	0.6	0.94	49.44
17	80.8	81.9	1.1	1.32	50.76
18	77.8	78.9	1.1	1.32	52.08
19	75.3	76.9	1.6	1.79	53.88
20	72.0	74.7	2.7	0.66	54.54
21	70.0	72.1	2.1	-0.09	54.44
22	68.2	70.6	2.4	0.47	54.91
23	66.5	69.2	2.7	0.38	55.29
24	65.0	67.7	2.7	0.57	55.86
25	66.6	69.1	2.5	0.57	56.43
26	72.6	72.2	-0.4	0.47	56.90
27	80.3	79.1	-1.2	1.13	58.03
28	86.1	84.7	-1.4	2.08	60.11
29	90.6	89.2	-1.4	3.12	63.23
30	94.6	93.1	-1.5	3.40	66.62
31	98.1	97.3	-0.8	4.25	70.87
32	101.2	99.8	-1.4	4.53	75.41
33	103.4	102.5	-0.9	4.44	79.85
34	104.9	103.4	-1.5	3.84	83.68
35	105.0	103.5	-1.5	4.10	87.78
36	104.2	103.6	-0.6	3.47	91.25

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	101.3	0.2	1.89	93.15
38	95.3	96.2	0.9	1.58	94.72
39	88.8	90.2	1.4	0.63	95.35
40	84.4	85.4	1	0.00	95.35
41	80.8	81.3	0.5	0.00	95.35
42	77.8	77.7	-0.1	0.00	95.35
43	75.3	75.4	0.1	0.00	95.35
44	72	72.9	0.9	-0.32	95.04
45	70	70.2	0.2	-0.32	94.72
46	68.2	68.5	0.3	-0.32	94.41
47	66.5	67.3	0.8	0.00	94.41
48	65	67	2	-0.32	94.09
49	66.6	67.2	0.6	0.00	94.09
50	72.6	72.5	-0.1	0.00	94.09
51	80.3	78.8	-1.5	0.63	94.72
52	86.1	84.6	-1.5	1.58	96.30
53	90.6	89.1	-1.5	2.84	99.14
54	94.6	93	-1.6	3.15	102.29
55	98.1	97.2	-0.9	3.47	105.76
56	101.2	99.8	-1.4	4.42	110.18
57	103.4	102.6	-0.8	4.10	114.28
58	104.9	104	-0.9	4.42	118.69
59	105	104.6	-0.4	3.78	122.48
60	104.2	103.6	-0.6	2.52	125.00
61	101.1	100.5	-0.6	1.89	126.89
62	95.3	97.6	2.3	1.26	128.15
63	88.8	91.4	2.6	0.32	128.47
64	84.4	84.7	0.3	0.32	128.78
65	80.8	81.1	0.3	-0.63	128.15
66	77.8	77.7	-0.1	-0.32	127.84
67	75.3	75.6	0.3	-0.32	127.52
68	72	73.1	1.1	0.00	127.52
69	70	70.2	0.2	-1.26	126.26
70	68.2	88.6	20.4	0.00	126.26
71	66.5	67.1	0.6	-0.63	125.63
72	65	66.6	1.6	-0.32	125.31
Average Temperature Error (°F):			0.22		

Automotive Testing Laboratories, Inc.

Test Date: 5/14/93
Test Fuel: SBE
Vehicle: 2

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	63.5	-1.5	--	--
1	66.6	66.4	-0.2	0.85	0.85
2	72.6	72.2	-0.4	1.11	1.96
3	80.3	77.9	-2.4	1.93	3.89
4	86.1	83.9	-2.2	3.17	7.06
5	90.6	88.7	-1.9	4.33	11.39
6	94.6	92.7	-1.9	4.72	16.10
7	98.1	96.7	-1.4	4.90	21.01
8	101.2	98.2	-3.0	1.54	22.55
9	103.4	101.8	-1.6	4.59	27.14
10	104.9	103.9	-1.0	3.99	31.13
11	105.0	104.4	-0.6	2.92	34.05
12	104.2	104.2	0.0	1.98	36.03
13	101.1	101.3	0.2	1.79	37.82
14	95.3	96.0	0.7	3.39	41.21
15	88.8	90.2	1.4	3.11	44.32
16	84.4	85.1	0.7	2.45	46.77
17	80.8	81.3	0.5	1.88	48.65
18	77.8	77.9	0.1	1.51	50.16
19	75.3	76.3	1.0	1.32	51.48
20	72.0	72.3	0.3	0.94	52.42
21	70.0	70.1	0.1	0.66	53.08
22	68.2	68.7	0.5	0.66	53.74
23	66.5	67.7	1.2	0.38	54.12
24	65.0	67.2	2.2	0.28	54.40
25	66.6	66.9	0.3	0.75	55.15
26	72.6	71.6	-1.0	0.57	55.72
27	80.3	78.3	-2.0	1.22	56.94
28	86.1	84.5	-1.6	2.45	59.39
29	90.6	88.9	-1.7	3.39	62.78
30	94.6	93.1	-1.5	4.33	67.12
31	98.1	97.1	-1.0	4.43	71.55
32	101.2	100.0	-1.2	4.99	76.54
33	103.4	102.7	-0.7	5.09	81.63
34	104.9	103.4	-1.5	2.67	84.30
35	105.0	104.7	-0.3	2.20	86.50
36	104.2	104.0	-0.2	4.09	90.59

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	103.1	2	3.78	94.36
38	95.3	96.4	1.1	2.52	96.88
39	88.8	90.5	1.7	1.57	98.45
40	84.4	85.2	0.8	0.94	99.40
41	80.8	81.4	0.6	0.63	100.03
42	77.8	78	0.2	0.00	100.03
43	75.3	75.8	0.5	0.63	100.66
44	72	72.3	0.3	0.00	100.66
45	70	70.4	0.4	0.00	100.66
46	68.2	69	0.8	-0.31	100.34
47	66.5	67.8	1.3	0.31	100.66
48	65	67.3	2.3	0.31	100.97
49	66.6	67	0.4	0.00	100.97
50	72.6	72.2	-0.4	-0.63	100.34
51	80.3	78.5	-1.8	1.26	101.60
52	86.1	84.5	-1.6	1.89	103.49
53	90.6	88.8	-1.8	3.15	106.63
54	94.6	92.9	-1.7	4.09	110.72
55	98.1	96.9	-1.2	4.09	114.81
56	101.2	100	-1.2	4.09	118.90
57	103.4	102.6	-0.8	5.03	123.94
58	104.9	104.2	-0.7	5.35	129.29
59	105	104.7	-0.3	4.09	133.38
60	104.2	104	-0.2	0.94	134.32
61	101.1	101.9	0.8	2.83	137.15
62	95.3	98.6	3.3	2.20	139.35
63	88.8	91.7	2.9	1.26	140.61
64	84.4	85.7	1.3	0.31	140.93
65	80.8	81.9	1.1	0.31	141.24
66	77.8	78.3	0.5	0.00	141.24
67	75.3	75.4	0.1	-0.63	140.61
68	72	73.4	1.4	0.00	140.61
69	70	71.8	1.8	0.00	140.61
70	68.2	70.7	2.5	-0.31	140.30
71	66.5	69.5	3	-0.31	139.98
72	65	68	3	0.00	139.98

Average Temperature Error (°F): 0.01

Automotive Testing Laboratories, Inc.

Test Date: 12/16/93
Test Fuel: Base
Vehicle: 3

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.6	-1.4	--	--
1	66.6	66.7	0.1	0.64	0.64
2	72.6	72.5	-0.1	0.57	1.20
3	80.3	79.7	-0.6	0.64	1.85
4	86.1	85.8	-0.3	0.76	2.60
5	90.6	90.3	-0.3	1.05	3.65
6	94.6	93.9	-0.7	2.18	5.83
7	98.1	97.6	-0.5	3.61	9.44
8	101.2	100.2	-1.0	4.45	13.89
9	103.4	102.9	-0.5	5.04	18.93
10	104.9	104.2	-0.7	5.30	24.22
11	105.0	104.9	-0.1	5.36	29.58
12	104.2	103.6	-0.6	3.47	33.06
13	101.1	100.6	-0.5	2.51	35.57
14	95.3	95.2	-0.1	1.64	37.21
15	88.8	88.7	-0.1	1.06	38.27
16	84.4	84.4	0.0	0.48	38.75
17	80.8	80.8	0.0	0.48	39.24
18	77.8	77.7	-0.1	0.39	39.62
19	75.3	75.2	-0.1	0.39	40.01
20	72.0	72.0	0.0	0.19	40.20
21	70.0	70.2	0.2	0.29	40.49
22	68.2	0.0	-68.2	0.02	40.51
23	66.5	0.0	-66.5	0.03	40.55
24	65.0	64.8	-0.2	0.03	40.58
25	66.6	66.4	-0.2	0.00	40.58
26	72.6	72.2	-0.4	0.32	40.90
27	80.3	80.3	0.0	0.96	41.86
28	86.1	85.9	-0.2	1.52	43.39
29	90.6	90.3	-0.3	2.03	45.41
30	94.6	94.2	-0.4	3.57	48.99
31	98.1	97.3	-0.8	4.63	53.62
32	101.2	100.5	-0.7	5.50	59.12
33	103.4	103.2	-0.2	5.41	64.53
34	104.9	104.3	-0.6	5.60	70.12
35	105.0	104.6	-0.4	4.92	75.05
36	104.2	103.8	-0.4	3.19	78.23

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	100.5	-0.6	2.22	80.45
38	95.3	95.3	0	1.35	81.80
39	88.8	88.3	-0.5	0.77	82.58
40	84.4	84.2	-0.2	0.39	82.96
41	80.8	80.7	-0.1	-0.48	82.48
42	77.8	77.9	0.1	0.10	82.58
43	75.3	75.2	-0.1	0.00	82.58
44	72	71.9	-0.1	0.19	82.77
45	70	69.9	-0.1	0.00	82.77
46	68.2	67.9	-0.3	0.00	82.77
47	66.5	66.7	0.2	-0.10	82.67
48	65	65	0	-0.10	82.58
49	66.6	66.6	0	0.00	82.58
50	72.6	72.6	0	0.48	83.06
51	80.3	80.2	-0.1	0.68	83.73
52	86.1	85.9	-0.2	1.06	84.80
53	90.6	90.5	-0.1	2.12	86.92
54	94.6	94.4	-0.2	2.48	89.40
55	98.1	97.8	-0.3	4.82	94.21
56	101.2	100.4	-0.8	5.78	99.99
57	103.4	103	-0.4	5.46	105.45
58	104.9	104.2	-0.7	5.46	110.91
59	105	104.8	-0.2	4.50	115.41
60	104.2	103.8	-0.4	3.21	118.62
61	101.1	100.8	-0.3	2.25	120.87
62	95.3	95	-0.3	1.28	122.15
63	88.8	88.8	0	0.32	122.48
64	84.4	84.4	0	0.32	122.80
65	80.8	80.8	0	0.00	122.80
66	77.8	77.8	0	-0.32	122.48
67	75.3	74.9	-0.4	-0.32	122.15
68	72	71.8	-0.2	-0.32	121.83
69	70	69.7	-0.3	-0.32	121.51
70	68.2	68.2	0	0.00	121.51
71	66.5	66.7	0.2	-0.32	121.19
72	65	65.1	0.1	-0.32	120.87

Average Temperature Error (°F): -2.10

Automotive Testing Laboratories, Inc.

Test Date: 12/8/93
Test Fuel: Phase 1
Vehicle: 3

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative	Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.5	-0.5	--	--	37	101.1	100.8	-0.3	2.36	73.86
1	66.6	66.6	0.0	0.67	0.67	38	95.3	95.3	0	1.41	75.28
2	72.6	72.6	0.0	0.57	1.24	39	88.8	88.9	0.1	0.66	75.94
3	80.3	80.1	-0.2	0.65	1.89	40	84.4	84.4	0	0.47	76.41
4	86.1	86.0	-0.1	0.72	2.61	41	80.8			0.09	76.50
5	90.6	90.5	-0.1	0.97	3.58	42	77.8	77.9	0.1	0.09	76.60
6	94.6	94.1	-0.5	1.54	5.12	43	75.3	75.3	0	0.19	76.78
7	98.1	97.9	-0.2	2.75	7.88	44	72	72	0	0.00	76.78
8	101.2	100.6	-0.6	3.62	11.50	45	70	70.1	0.1	0.09	76.88
9	103.4	102.6	-0.8	4.61	16.11	46	68.2	68.2	0	0.09	76.97
10	104.9	104.2	-0.7	4.42	20.53	47	66.5	66.6	0.1	0.00	76.97
11	105.0	104.8	-0.2	4.17	24.69	48	65	65.2	0.2	0.00	76.97
12	104.2	103.6	-0.6	4.14	28.83	49	66.6	66.6	0	0.00	76.97
13	101.1	100.2	-0.9	2.36	31.19	50	72.6	72.5	-0.1	0.57	77.54
14	95.3	95.3	0.0	1.88	33.07	51	80.3	79.6	-0.7	0.75	78.29
15	88.8	88.8	0.0	1.04	34.11	52	86.1	86.1	0	0.94	79.23
16	84.4	84.3	-0.1	0.85	34.95	53	90.6	90.1	-0.5	1.88	81.12
17	80.8	80.5	-0.3	0.19	35.14	54	94.6	93.9	-0.7	2.11	83.23
18	77.8	77.8	0.0	0.38	35.52	55	98.1			4.70	87.93
19	75.3	75.3	0.0	0.38	35.90	56	101.2	100	-1.2	4.70	92.63
20	72.0	72.0	0.0	0.28	36.18	57	103.4	100	-3.4	4.70	97.34
21	70.0	70.0	0.0	0.19	36.37	58	104.9	104.4	-0.5	5.64	102.98
22	68.2	68.1	-0.1	0.28	36.65	59	105	104.4	-0.6	4.08	107.05
23	66.5	66.5	0.0	0.19	36.84	60	104.2	103.7	-0.5	3.45	110.50
24	65.0	65.0	0.0	0.19	37.03	61	101.1	100.7	-0.4	2.82	113.32
25	66.6	66.6	0.0	0.28	37.31	62	95.3	94.9	-0.4	0.31	113.64
26	72.6	72.1	-0.5	0.28	37.59	63	88.8	88.5	-0.3	0.00	113.64
27	80.3	80.3	0.0	0.75	38.35	64	84.4	84.8	0.4	0.31	113.95
28	86.1	85.9	-0.2	0.85	39.19	65	80.8	80.6	-0.2	0.00	113.95
29	90.6	90.0	-0.6	1.70	40.89	66	77.8	77.8	0	-0.31	113.64
30	94.6	94.1	-0.5	3.30	44.19	67	75.3	75.1	-0.2	-0.31	113.32
31	98.1	97.5	-0.6	4.33	48.52	68	72	72.3	0.3	0.00	113.32
32	101.2	100.3	-0.9	4.99	53.51	69	70	70.2	0.2	-0.63	112.70
33	103.4	102.9	-0.5	5.18	58.70	70	68.2	68.6	0.4	-0.31	112.38
34	104.9	104.3	-0.6	4.43	63.12	71	66.5	66.7	0.2	0.00	112.38
35	105.0	104.8	-0.2	4.90	68.02	72	65	65	0	-0.31	112.07
36	104.2	103.9	-0.3	3.49	71.51	Average Temperature Error (°F):			-0.26		

Automotive Testing Laboratories, Inc.

Test Date: 11/18/93
Test Fuel: Phase 2
Vehicle: 3

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative	Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	63.6	-1.4	--	--	37	101.1	100.6	-0.5	1.76	49.29
1	66.6	66.2	-0.4	0.50	0.50	38	95.3	95.3	0	1.21	50.50
2	72.6	72.1	-0.5	0.48	0.97	39	88.8	88.6	-0.2	0.65	51.15
3	80.3	80.9	0.6	0.60	1.58	40	84.4	84.3	-0.1	0.19	51.34
4	86.1	85.6	-0.5	0.57	2.15	41	80.8	80.7	-0.1	0.19	51.52
5	90.6	89.9	-0.7	0.64	2.79	42	77.8	78	0.2	0.09	51.62
6	94.6	93.9	-0.7	0.81	3.60	43	75.3	75.4	0.1	0.09	51.71
7	98.1	97.6	-0.5	1.01	4.61	44	72	72.2	0.2	0.00	51.71
8	101.2	100.7	-0.5	1.35	5.96	45	70	70	0	0.09	51.80
9	103.4	102.7	-0.7	2.00	7.96	46	68.2	68.2	0	0.00	51.80
10	104.9	104.1	-0.8	2.34	10.30	47	66.5	66.6	0.1	0.00	51.80
11	105.0	104.2	-0.8	2.59	12.90	48	65	65	0	0.00	51.80
12	104.2	103.5	-0.7	2.29	15.18	49	66.6	66.7	0.1	0.09	51.89
13	101.1	100.6	-0.5	1.76	16.94	50	72.6	72.2	-0.4	0.28	52.17
14	95.3	95.3	0.0	1.17	18.12	51	80.3	79.7	-0.6	0.65	52.82
15	88.8	88.4	-0.4	0.74	18.86	52	86.1	85.4	-0.7	0.93	53.75
16	84.4	84.3	-0.1	0.49	19.35	53	90.6	89.8	-0.8	1.39	55.14
17	80.8	80.5	-0.3	0.43	19.78	54	94.6	94.1	-0.5	2.14	57.28
18	77.8	77.5	-0.3	0.37	20.15	55	98.1	97.4	-0.7	2.88	60.16
19	75.3	75.1	-0.2	0.31	20.46	56	101.2	100.4	-0.8	3.71	63.87
20	72.0	71.9	-0.1	0.25	20.71	57	103.4	103.1	-0.3	3.99	67.87
21	70.0	70.2	0.2	0.22	20.93	58	104.9	104.2	-0.7	3.99	71.86
22	68.2	68.3	0.1	0.22	21.14	59	105	104.3	-0.7	3.53	75.39
23	66.5	66.5	0.0	0.19	21.33	60	104.2	103.8	-0.4	2.69	78.08
24	65.0	65.1	0.1	0.15	21.48	61	101.1	100.2	-0.9	2.04	80.12
25	66.6	66.4	-0.2	0.25	21.73	62	95.3	95.2	-0.1	0.74	80.87
26	72.6	72.2	-0.4	0.37	22.10	63	88.8	88.8	0	0.46	81.33
27	80.3	79.9	-0.4	0.56	22.66	64	84.4	84.2	-0.2	0.09	81.42
28	86.1	85.5	-0.6	0.74	23.40	65	80.8	80.8	0	0.00	81.42
29	90.6	89.9	-0.7	1.14	24.54	66	77.8	77.8	0	-0.09	81.33
30	94.6	93.9	-0.7	1.82	26.36	67	75.3	75.3	0	-0.09	81.24
31	98.1	97.4	-0.7	3.52	29.89	68	72	72	0	-0.19	81.05
32	101.2	100.3	-0.9	3.44	33.32	69	70	70	0	-0.19	80.87
33	103.4	102.6	-0.8	3.99	37.31	70	68.2	68.2	0	-0.19	80.68
34	104.9	104.4	-0.5	3.99	41.31	71	66.5	66.4	-0.1	-0.19	80.50
35	105.0	104.4	-0.6	3.44	44.74	72	65	65.2	0.2	-0.19	80.31
36	104.2	103.7	-0.5	2.79	47.53	Average Temperature Error (°F):			-0.33		

Automotive Testing Laboratories, Inc.

Test Date: 6/29/93
Test Fuel: Base
Vehicle: 5

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative	Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.1	-0.9	--	--	37	101.1	99.8	-1.3	1.31	27.40
1	66.6	66.0	-0.6	0.08	0.08	38	95.3	95.3	0	0.88	28.28
2	72.6	69.2	-3.4	0.08	0.16	39	88.8	88.8	0	0.38	28.65
3	80.3	77.3	-3.0	0.08	0.24	40	84.4	84.4	0	0.00	28.65
4	86.1	84.6	-1.5	0.13	0.37	41	80.8	80.8	0	0.00	28.65
5	90.6	89.4	-1.2	0.17	0.55	42	77.8	77.8	0	-0.09	28.56
6	94.6	92.8	-1.8	0.19	0.74	43	75.3	75.4	0.1	-0.09	28.47
7	98.1	96.9	-1.2	0.22	0.95	44	72	72	0	-0.09	28.37
8	101.2	99.2	-2.0	0.23	1.18	45	70	70.1	0.1	-0.19	28.18
9	103.4	102.2	-1.2	0.30	1.49	46	68.2	68	-0.2	0.00	28.18
10	104.9	103.5	-1.4	0.77	2.26	47	66.5	66.4	-0.1	-0.09	28.09
11	105.0	104.9	-0.1	2.10	4.35	48	65	65.2	0.2	-0.09	28.00
12	104.2	104.2	0.0	0.94	5.29	49	66.6	66.8	0.2	0.00	28.00
13	101.1	99.8	-1.3	1.25	6.54	50	72.6	71.6	-1	0.00	28.00
14	95.3	95.0	-0.3	0.83	7.37	51	80.3	79.3	-1	0.19	28.18
15	88.8	88.7	-0.1	0.43	7.80	52	86.1	84.5	-1.6	0.38	28.56
16	84.4	84.3	-0.1	0.04	7.84	53	90.6	88.2	-2.4	0.66	29.22
17	80.8	80.8	0.0	0.01	7.84	54	94.6	93.3	-1.3	0.66	29.87
18	77.8	77.9	0.1	-0.01	7.84	55	98.1	97.3	-0.8	1.31	31.19
19	75.3	75.2	-0.1	0.00	7.84	56	101.2	99.8	-1.4	3.19	34.37
20	72.0	72.0	0.0	-0.01	7.83	57	103.4	102.8	-0.6	4.13	38.50
21	70.0	69.8	-0.2	-0.02	7.81	58	104.9	104	-0.9	4.41	42.91
22	68.2	68.2	0.0	-0.01	7.80	59	105	102.4	-2.6	3.10	46.00
23	66.5	66.6	0.1	0.00	7.80	60	104.2	103.4	-0.8	2.25	48.26
24	65.0	65.3	0.3	-0.04	7.76	61	101.1	99.9	-1.2	1.31	49.57
25	66.6	66.7	0.1	0.03	7.79	62	95.3	95.4	0.1	0.94	50.51
26	72.6	72.0	-0.6	0.07	7.85	63	88.8	88.8	0	0.38	50.88
27	80.3	80.0	-0.3	0.12	7.98	64	84.4	84.6	0.2	-0.09	50.79
28	86.1	84.9	-1.2	0.44	8.42	65	80.8	80.9	0.1	-0.19	50.60
29	90.6	90.2	-0.4	0.61	9.03	66	77.8	77.8	0	-0.09	50.51
30	94.6	93.7	-0.9	0.75	9.78	67	75.3	75.4	0.1	-0.09	50.41
31	98.1	97.3	-0.8	1.06	10.84	68	72	72.1	0.1	-0.19	50.23
32	101.2	100.0	-1.2	2.44	13.28	69	70	69.8	-0.2	-0.19	50.04
33	103.4	102.6	-0.8	3.47	16.76	70	68.2	68.4	0.2	-0.09	49.94
34	104.9	103.9	-1.0	3.79	20.54	71	66.5	66.5	0	-0.28	49.66
35	105.0	104.8	-0.2	3.29	23.83	72	65	65	0	0.00	49.66
36	104.2	103.7	-0.5	2.25	26.08	Average Temperature Error (°F):			-0.60		

Test Date: 7/30/93
Test Fuel: Phase 1
Vehicle: 5

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.2	-1.8	--	--
1	66.6	65.5	-1.1	0.08	0.08
2	72.6	72.5	-0.1	0.08	0.16
3	80.3	79.8	-0.5	0.09	0.24
4	86.1	85.5	-0.6	0.10	0.35
5	90.6	90.3	-0.3	0.12	0.47
6	94.6	94.0	-0.6	0.14	0.61
7	98.1	97.8	-0.3	0.16	0.77
8	101.2	100.6	-0.6	0.17	0.94
9	103.4	103.0	-0.4	0.18	1.11
10	104.9	104.5	-0.4	0.19	1.30
11	105.0	104.8	-0.2	0.18	1.48
12	104.2	103.6	-0.6	0.17	1.65
13	101.1	99.5	-1.6	0.15	1.80
14	95.3	94.8	-0.5	0.18	1.98
15	88.8	87.5	-1.3	0.01	1.99
16	84.4	83.6	-0.8	0.02	2.01
17	80.8	80.6	-0.2	0.01	2.02
18	77.8	78.0	0.2	0.00	2.02
19	75.3	75.3	0.0	0.02	2.04
20	72.0	72.1	0.1	0.00	2.04
21	70.0	70.2	0.2	0.00	2.03
22	68.2	68.1	-0.1	0.00	2.03
23	66.5	66.5	0.0	-0.01	2.03
24	65.0	65.1	0.1	0.00	2.03
25	66.6	66.4	-0.2	0.01	2.04
26	72.6	72.1	-0.5	0.05	2.09
27	80.3	80.3	0.0	0.09	2.18
28	86.1	85.9	-0.2	0.20	2.38
29	90.6	90.1	-0.5	0.26	2.65
30	94.6	93.8	-0.8	0.32	2.97
31	98.1	97.3	-0.8	0.37	3.33
32	101.2	100.6	-0.6	0.43	3.77
33	103.4	103.0	-0.4	0.62	4.39
34	104.9	104.5	-0.4	0.92	5.31
35	105.0	104.6	-0.4	1.13	6.44
36	104.2	103.7	-0.5	1.04	7.47

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	99.5	-1.6	0.87	8.35
38	95.3	94.6	-0.7	0.63	8.98
39	88.8	87.7	-1.1	0.41	9.38
40	84.4	83.5	-0.9	0.00	9.38
41	80.8	80.7	-0.1	-0.03	9.35
42	77.8	77.5	-0.3	0.00	9.35
43	75.3	75.3	0	-0.06	9.29
44	72	72	0	-0.03	9.26
45	70	70	0	-0.03	9.23
46	68.2	68.3	0.1	0.00	9.23
47	66.5	66.5	0	-0.03	9.20
48	65	64.9	-0.1	0.00	9.20
49	66.6	66.6	0	0.00	9.20
50	72.6	72.2	-0.4	0.09	9.29
51	80.3	79.6	-0.7	0.13	9.42
52	86.1	86.1	0	0.35	9.76
53	90.6	90	-0.6	0.47	10.23
54	94.6	94	-0.6	0.66	10.89
55	98.1	97.4	-0.7	0.82	11.71
56	101.2	100.7	-0.5	1.07	12.78
57	103.4	102.8	-0.6	1.70	14.47
58	104.9	104.6	-0.3	2.13	16.61
59	105	104.8	-0.2	2.20	18.80
60	104.2	103.6	-0.6	1.66	20.47
61	101.1	99.9	-1.2	1.07	21.53
62	95.3	94.7	-0.6	0.91	22.45
63	88.8	88.2	-0.6	0.47	22.92
64	84.4	83.8	-0.6	-0.03	22.88
65	80.8	80.7	-0.1	-0.09	22.79
66	77.8	77.7	-0.1	-0.03	22.76
67	75.3	75.2	-0.1	-0.09	22.67
68	72	72	0	-0.09	22.57
69	70	69.9	-0.1	-0.09	22.48
70	68.2	68.1	-0.1	-0.03	22.45
71	66.5	66.7	0.2	-0.09	22.35
72	65	65.3	0.3	-0.06	22.29

Average Temperature Error (°F): -0.41

Automotive Testing Laboratories, Inc.

Test Date: 7/23/93
Test Fuel: Phase 2
Vehicle: 5

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	64.1	-0.9	--	--
1	66.6	66.1	-0.5	0.10	0.10
2	72.6	72.1	-0.5	0.09	0.19
3	80.3	79.0	-1.3	0.08	0.27
4	86.1	85.6	-0.5	0.10	0.37
5	90.6	90.1	-0.5	0.11	0.48
6	94.6	93.4	-1.2	0.13	0.60
7	98.1	97.4	-0.7	0.14	0.74
8	101.2	99.3	-1.9	0.14	0.89
9	103.4	102.3	-1.1	0.15	1.04
10	104.9	103.5	-1.4	0.16	1.20
11	105.0	104.3	-0.7	0.16	1.36
12	104.2	103.7	-0.5	0.15	1.51
13	101.1	99.4	-1.7	0.12	1.63
14	95.3	95.2	-0.1	0.08	1.71
15	88.8	88.7	-0.1	0.05	1.76
16	84.4	84.5	0.1	0.02	1.78
17	80.8	80.7	-0.1	0.01	1.79
18	77.8	77.8	0.0	0.01	1.80
19	75.3	75.4	0.1	0.00	1.80
20	72.0	73.0	1.0	0.00	1.80
21	70.0	70.0	0.0	0.00	1.79
22	68.2	68.2	0.0	-0.01	1.79
23	66.5	66.4	-0.1	0.00	1.78
24	65.0	65.0	0.0	-0.01	1.78
25	66.6	66.7	0.1	0.01	1.79
26	72.6	72.3	-0.3	0.03	1.82
27	80.3	80.0	-0.3	0.07	1.89
28	86.1	85.5	-0.6	0.11	2.00
29	90.6	89.8	-0.8	0.14	2.14
30	94.6	93.5	-1.1	0.16	2.31
31	98.1	97.2	-0.9	0.19	2.50
32	101.2	100.0	-1.2	0.16	2.66
33	103.4	102.7	-0.7	0.23	2.88
34	104.9	104.0	-0.9	0.21	3.09
35	105.0	104.8	-0.2	0.24	3.32
36	104.2	103.6	-0.6	0.22	3.54

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	99.6	-1.5	0.18	3.72
38	95.3	95.1	-0.2	0.14	3.86
39	88.8	88.6	-0.2	0.10	3.96
40	84.4	84.4	0	-0.01	3.96
41	80.8	80.8	0	-0.02	3.94
42	77.8	78	0.2	-0.03	3.91
43	75.3	75.3	0	-0.04	3.87
44	72	72.2	0.2	-0.01	3.86
45	70	69.9	-0.1	-0.03	3.83
46	68.2	68.5	0.3	-0.03	3.80
47	66.5	66.5	0	-0.02	3.79
48	65	65	0	-0.02	3.77
49	66.6	66.5	-0.1	0.01	3.78
50	72.6	72.3	-0.3	0.05	3.82
51	80.3	80	-0.3	0.10	3.93
52	86.1	85.6	-0.5	0.19	4.12
53	90.6	90.9	0.3	0.41	4.53
54	94.6	93.6	-1	0.29	4.82
55	98.1	94.4	-3.7	0.41	5.24
56	101.2	100.1	-1.1	0.49	5.73
57	103.4	102.8	-0.6	0.60	6.33
58	104.9	104.2	-0.7	0.72	7.04
59	105	104.4	-0.6	0.87	7.91
60	104.2	103.7	-0.5	0.75	8.67
61	101.1	99.7	-1.4	0.57	9.23
62	95.3	95	-0.3	0.41	9.64
63	88.8	88.4	-0.4	0.31	9.95
64	84.4	84.6	0.2	0.00	9.95
65	80.8	80.8	0	-0.03	9.92
66	77.8	77.6	-0.2	-0.06	9.86
67	75.3	75.2	-0.1	-0.06	9.80
68	72	72	0	-0.03	9.77
69	70	70	0	-0.06	9.70
70	68.2	68.2	0	-0.03	9.67
71	66.5	66.5	0	-0.03	9.64
72	65	65	0	-0.03	9.61

Average Temperature Error (°F): -0.45

Automotive Testing Laboratories, Inc.

Test Date: 6/23/93
Test Fuel: SBE
Vehicle: 5

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.4	-0.6	--	--
1	66.6	66.4	-0.2	0.08	0.08
2	72.6	69.3	-3.3	0.08	0.16
3	80.3	76.3	-4.0	0.08	0.24
4	86.1	82.1	-4.0	0.12	0.36
5	90.6	87.8	-2.8	0.16	0.52
6	94.6	93.2	-1.4	0.20	0.72
7	98.1	97.5	-0.6	0.20	0.92
8	101.2	100.6	-0.6	0.23	1.15
9	103.4	103.2	-0.2	0.28	1.43
10	104.9	104.8	-0.1	0.25	1.68
11	105.0	104.9	-0.1	0.29	1.97
12	104.2	103.7	-0.5	0.27	2.24
13	101.1	100.7	-0.4	0.20	2.44
14	95.3	95.6	0.3	0.14	2.58
15	88.8	89.0	0.2	0.13	2.71
16	84.4	84.4	0.0	0.04	2.75
17	80.8	80.9	0.1	0.01	2.76
18	77.8	77.7	-0.1	0.06	2.81
19	75.3	75.3	0.0	0.00	2.81
20	72.0	72.1	0.1	0.00	2.81
21	70.0	70.3	0.3	0.01	2.82
22	68.2	68.5	0.3	0.00	2.82
23	66.5	66.6	0.1	0.01	2.83
24	65.0	64.9	-0.1	-0.01	2.82
25	66.6	66.5	-0.1	0.03	2.85
26	72.6	71.0	-1.6	0.05	2.90
27	80.3	81.3	1.0	0.13	3.03
28	86.1	85.4	-0.7	0.22	3.25
29	90.6	89.7	-0.9	0.34	3.59
30	94.6	92.6	-2.0	0.33	3.91
31	98.1	97.1	-1.0	0.44	4.36
32	101.2	100.3	-0.9	0.51	4.86
33	103.4	102.7	-0.7	0.63	5.49
34	104.9	103.5	-1.4	0.92	6.42
35	105.0	104.4	-0.6	0.94	7.36
36	104.2	103.6	-0.6	1.04	8.40

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
37	101.1	99.5	-1.6	0.86	9.26
38	95.3	95.6	0.3	0.63	9.88
39	88.8	88.9	0.1	0.35	10.23
40	84.4	84.4	0	0.00	10.23
41	80.8	81.2	0.4	-0.03	10.20
42	77.8	77.8	0	-0.03	10.17
43	75.3	75.4	0.1	-0.06	10.10
44	72	72.2	0.2	-0.03	10.07
45	70	70	0	-0.06	10.01
46	68.2	68.2	0	-0.03	9.98
47	66.5	66.5	0	-0.03	9.95
48	65	65.3	0.3	-0.06	9.88
49	66.6	66.8	0.2	0.00	9.88
50	72.6	72	-0.6	0.06	9.95
51	80.3	79.8	-0.5	0.16	10.10
52	86.1	85.6	-0.5	0.35	10.45
53	90.6	90.1	-0.5	0.47	10.92
54	94.6	93.9	-0.7	0.63	11.55
55	98.1	97.8	-0.3	0.82	12.36
56	101.2	100.4	-0.8	1.04	13.40
57	103.4	103	-0.4	1.51	14.90
58	104.9	104.2	-0.7	2.01	16.91
59	105	104.5	-0.5	2.23	19.14
60	104.2	103.6	-0.6	1.76	20.89
61	101.1	99.5	-1.6	1.19	22.09
62	95.3	94.8	-0.5	0.72	22.81
63	88.8	88.1	-0.7	0.44	23.25
64	84.4	84	-0.4	-0.13	23.12
65	80.8	80.6	-0.2	-0.03	23.09
66	77.8	77.8	0	-0.16	22.93
67	75.3	75.3	0	-0.03	22.90
68	72	72.4	0.4	-0.19	22.71
69	70	69.9	-0.1	-0.09	22.62
70	68.2	68.2	0	-0.09	22.53
71	66.5	66.6	0.1	-0.09	22.43
72	65	64.9	-0.1	-0.06	22.37

Average Temperature Error (°F): -0.50

Automotive Testing Laboratories, Inc.

Test Date: 11/01/93
Test Fuel: Base
Vehicle: 7

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative	Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.1	-0.9	--	--	37	101.1	100.5	-0.6	0.38	37.40
1	66.6	66.5	-0.1	0.41	0.41	38	95.3	94.8	-0.5	0.28	37.68
2	72.6	72.3	-0.3	0.50	0.91	39	88.8	88.2	-0.6	0.09	37.77
3	80.3	79.4	-0.9	0.74	1.65	40	84.4	84.1	-0.3	0.00	37.77
4	86.1	86.0	-0.1	1.12	2.77	41	80.8	80.3	-0.5	0.00	37.77
5	90.6	90.0	-0.6	1.46	4.23	42	77.8	77.9	0.1	0.28	38.06
6	94.6	94.7	0.1	1.53	5.76	43	75.3	75.2	-0.1	0.57	38.63
7	98.1	97.8	-0.3	1.35	7.11	44	72	72.3	0.3	0.66	39.29
8	101.2	100.9	-0.3	1.29	8.40	45	70	70.1	0.1	0.57	39.86
9	103.4	102.7	-0.7	1.42	9.82	46	68.2	68.3	0.1	0.57	40.43
10	104.9	104.2	-0.7	1.70	11.52	47	66.5	66.8	0.3	0.47	40.90
11	105.0	104.9	-0.1	1.48	13.00	48	65	65.2	0.2	0.47	41.37
12	104.2	103.8	-0.4	0.88	13.89	49	66.6	66.6	0	0.47	41.85
13	101.1	100.8	-0.3	0.57	14.46	50	72.6	72.6	0	0.57	42.42
14	95.3	95.3	0.0	0.35	14.80	51	80.3	80.5	0.2	1.23	43.65
15	88.8	88.8	0.0	0.22	15.02	52	86.1	85.8	-0.3	1.42	45.07
16	84.4	84.3	-0.1	0.19	15.21	53	90.6	90.8	0.2	1.61	46.68
17	80.8	80.9	0.1	0.28	15.50	54	94.6	94.4	-0.2	1.70	48.38
18	77.8	77.4	-0.4	0.66	16.16	55	98.1	97.9	-0.2	1.89	50.28
19	75.3	75.3	0.0	0.85	17.01	56	101.2	100.9	-0.3	1.80	52.08
20	72.0	71.8	-0.2	0.73	17.73	57	103.4	102.8	-0.6	2.37	54.44
21	70.0	69.9	-0.1	0.66	18.40	58	104.9	104.4	-0.5	2.18	56.62
22	68.2	68.2	0.0	0.57	18.96	59	105	104.5	-0.5	1.80	58.42
23	66.5	66.5	0.0	0.57	19.53	60	104.2	103.8	-0.4	1.04	59.46
24	65.0	65.0	0.0	0.47	20.00	61	101.1	100.7	-0.4	0.76	60.22
25	66.6	66.5	-0.1	0.47	20.48	62	95.3	95	-0.3	0.00	60.22
26	72.6	72.6	0.0	0.63	21.11	63	88.8	88.4	-0.4	-0.09	60.13
27	80.3	79.7	-0.6	0.91	22.02	64	84.4	84.4	0	-0.09	60.03
28	86.1	85.6	-0.5	1.26	23.28	65	80.8	80.6	-0.2	-0.09	59.94
29	90.6	90.3	-0.3	1.58	24.86	66	77.8	77.7	-0.1	0.09	60.03
30	94.6	94.4	-0.2	1.20	26.06	67	75.3	75.3	0	0.28	60.32
31	98.1	97.8	-0.3	1.58	27.63	68	72	72	0	0.66	60.98
32	101.2	100.6	-0.6	1.86	29.49	69	70	69.6	-0.4	0.57	61.55
33	103.4	102.7	-0.7	2.88	32.38	70	68.2	68.2	0	0.19	61.74
34	104.9	104.4	-0.5	1.99	34.36	71	66.5	66.3	-0.2	0.47	62.21
35	105.0	104.6	-0.4	1.61	35.98	72	65	65.3	0.3	0.47	62.68
36	104.2	103.4	-0.8	1.04	37.02	Average Temperature Error (°F):			-0.23		

Automotive Testing Laboratories, Inc.

Test Date: 10/25/93
Test Fuel: Phase 1
Vehicle: 7

	SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.0	-1.0	--	--
1	66.6	65.6	-1.0	0.29	0.29
2	72.6	72.1	-0.5	0.36	0.65
3	80.3	79.9	-0.4	0.57	1.22
4	86.1	85.5	-0.6	0.85	2.07
5	90.6	90.1	-0.5	0.81	2.88
6	94.6	94.0	-0.6	0.97	3.85
7	98.1	97.6	-0.5	1.06	4.91
8	101.2	99.9	-1.3	1.09	6.00
9	103.4	102.2	-1.2	1.11	7.10
10	104.9	103.5	-1.4	1.43	8.53
11	105.0	104.3	-0.7	1.34	9.87
12	104.2	103.7	-0.5	0.78	10.66
13	101.1	100.0	-1.1	0.63	11.28
14	95.3	95.0	-0.3	0.25	11.53
15	88.8	88.4	-0.4	0.19	11.72
16	84.4	84.3	-0.1	0.13	11.84
17	80.8	80.9	0.1	0.09	11.94
18	77.8	77.8	0.0	0.03	11.97
19	75.3	75.1	-0.2	0.09	12.06
20	72.0	72.0	0.0	0.13	12.19
21	70.0	70.4	0.4	0.06	12.25
22	68.2	68.3	0.1	0.13	12.38
23	66.5	66.7	0.2	0.09	12.47
24	65.0	64.9	-0.1	0.13	12.60
25	66.6	66.4	-0.2	0.25	12.85
26	72.6	72.0	-0.6	0.44	13.28
27	80.3	80.0	-0.3	0.72	14.00
28	86.1	85.3	-0.8	1.09	15.10
29	90.6	90.3	-0.3	1.31	16.41
30	94.6	94.1	-0.5	1.44	17.85
31	98.1	97.5	-0.6	1.60	19.44
32	101.2	100.4	-0.8	1.66	21.10
33	103.4	103.0	-0.4	1.97	23.07
34	104.9	104.3	-0.6	1.97	25.04
35	105.0	104.5	-0.5	1.56	26.61
36	104.2	103.7	-0.5	1.03	27.64

	SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative
37	101.1	100.8	-0.3	0.50	28.14
38	95.3	95.3	0	0.25	28.39
39	88.8	88.7	-0.1	0.09	28.48
40	84.4	84.4	0	0.06	28.55
41	80.8	80.8	0	-0.13	28.42
42	77.8	78	0.2	-0.16	28.26
43	75.3	75.3	0	-0.03	28.23
44	72	72.2	0.2	-0.09	28.14
45	70	70	0	0.00	28.14
46	68.2	68.2	0	-0.09	28.05
47	66.5	66.5	0	0.06	28.11
48	65	65.1	0.1	-0.03	28.08
49	66.6	66.4	-0.2	0.09	28.17
50	72.6	72.2	-0.4	0.41	28.58
51	80.3	80.2	-0.1	1.67	30.24
52	86.1	85.7	-0.4	1.32	31.56
53	90.6	90.4	-0.2	1.60	33.16
54	94.6	94.1	-0.5	-0.85	32.31
55	98.1	98	-0.1	4.42	36.73
56	101.2	100	-1.2	2.07	38.79
57	103.4	102.5	-0.9	2.07	40.86
58	104.9	103.5	-1.4	2.07	42.93
59	105	104.4	-0.6	1.97	44.90
60	104.2	103.5	-0.7	1.03	45.94
61	101.1	100.8	-0.3	0.66	46.59
62	95.3	95.3	0	0.38	46.97
63	88.8	88.8	0	-0.09	46.87
64	84.4	84.4	0	-0.09	46.78
65	80.8	80.8	0	-0.28	46.50
66	77.8	77.8	0	-0.56	45.94
67	75.3	75.2	-0.1	-0.19	45.75
68	72	72	0	-0.19	45.56
69	70	70.2	0.2	-0.28	45.28
70	68.2	68	-0.2	-0.09	45.18
71	66.5	66.3	-0.2	-0.09	45.09
72	65	65	0	-0.09	45.00
Average Temperature Error (°F):			-0.34		

Automotive Testing Laboratories, Inc.

Test Date: 12/09/93
Test Fuel: Phase 2
Vehicle: 7

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	61.7	-3.3	--	--
1	66.6	66.1	-0.5	1.00	1.00
2	72.6	72.6	0.0	0.93	1.92
3	80.3	79.9	-0.4	1.07	2.99
4	86.1	85.9	-0.2	1.73	4.72
5	90.6	90.1	-0.5	2.15	6.87
6	94.6	94.4	-0.2	2.24	9.11
7	98.1	97.6	-0.5	2.48	11.59
8	101.2	100.7	-0.5	2.70	14.29
9	103.4	102.8	-0.6	2.80	17.09
10	104.9	104.2	-0.7	2.74	19.83
11	105.0	104.9	-0.1	2.48	22.31
12	104.2	103.8	-0.4	2.04	24.35
13	101.1	100.8	-0.3	1.65	26.00
14	95.3	95.4	0.1	1.08	27.08
15	88.8	88.7	-0.1	0.76	27.85
16	84.4	84.3	-0.1	0.51	28.36
17	80.8	81.0	0.2	0.29	28.64
18	77.8	77.9	0.1	0.22	28.86
19	75.3	75.3	0.0	0.22	29.09
20	72.0	72.0	0.0	0.19	29.28
21	70.0	69.9	-0.1	0.06	29.34
22	68.2	68.2	0.0	0.13	29.47
23	66.5	66.5	0.0	0.10	29.56
24	65.0	65.0	0.0	0.03	29.60
25	66.6	66.6	0.0	0.99	30.58
26	72.6	72.1	-0.5	0.29	30.87
27	80.3	80.3	0.0	0.57	31.44
28	86.1	85.4	-0.7	1.15	32.59
29	90.6	90.4	-0.2	1.53	34.12
30	94.6	93.8	-0.8	1.91	36.04
31	98.1	97.7	-0.4	2.30	38.33
32	101.2	100.6	-0.6	2.39	40.72
33	103.4	102.7	-0.7	2.58	43.30
34	104.9	104.3	-0.6	2.58	45.89
35	105.0	104.5	-0.5	2.39	48.28
36	104.2	103.8	-0.4	1.82	50.10

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	100.6	-0.5	1.34	51.43
38	95.3	95.1	-0.2	0.96	52.39
39	88.8	88.8	0	0.48	52.87
40	84.4	84.6	0.2	0.19	53.06
41	80.8	80.8	0	-0.10	52.96
42	77.8	77.9	0.1	-0.19	52.77
43	75.3	75.3	0	-0.10	52.68
44	72	72	0	-0.10	52.58
45	70	69.8	-0.2	-0.10	52.49
46	68.2	68.2	0	-0.10	52.39
47	66.5	66.6	0.1	-0.19	52.20
48	65	65	0	-0.19	52.01
49	66.6	66.5	-0.1	0.00	52.01
50	72.6	72.6	0	0.19	52.20
51	80.3	80.2	-0.1	0.38	52.58
52	86.1	86	-0.1	1.24	53.83
53	90.6	89.9	-0.7	1.63	55.45
54	94.6	94	-0.6	1.82	57.27
55	98.1	97.5	-0.6	2.30	59.56
56	101.2	100.7	-0.5	2.20	61.76
57	103.4	102.6	-0.8	2.68	64.44
58	104.9	104.5	-0.4	2.49	66.93
59	105	104.7	-0.3	2.20	69.13
60	104.2	103.8	-0.4	1.72	70.85
61	101.1	100.6	-0.5	1.34	72.19
62	95.3	94.5	-0.8	0.57	72.76
63	88.8	88.6	-0.2	0.29	73.05
64	84.4	84.1	-0.3	-0.10	72.95
65	80.8	81.1	0.3	-0.38	72.57
66	77.8	78	0.2	-0.19	72.38
67	75.3	75.1	-0.2	-0.29	72.09
68	72	72.3	0.3	-0.38	71.71
69	70	69.9	-0.1	-0.19	71.52
70	68.2	68.2	0	-0.19	71.33
71	66.5	66	-0.5	-0.48	70.85
72	65	65	0	-0.10	70.75

Average Temperature Error (°F): -0.28

Automotive Testing Laboratories, Inc.

Test Date: 8/24/93
Test Fuel: Base
Vehicle: 8

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.4	-0.6	--	--
1	66.6	66.6	0.0	0.09	0.09
2	72.6	72.2	-0.4	0.10	0.18
3	80.3	80.0	-0.3	0.13	0.32
4	86.1	85.3	-0.8	0.17	0.49
5	90.6	90.0	-0.6	0.20	0.69
6	94.6	94.0	-0.6	0.23	0.92
7	98.1	97.3	-0.8	0.25	1.18
8	101.2	100.8	-0.4	0.25	1.42
9	103.4	103.0	-0.4	0.35	1.77
10	104.9	104.3	-0.6	0.82	2.59
11	105.0	104.7	-0.3	1.10	3.69
12	104.2	103.7	-0.5	0.80	4.49
13	101.1	99.7	-1.4	0.47	4.96
14	95.3	95.3	0.0	0.18	5.14
15	88.8	88.8	0.0	0.12	5.27
16	84.4	84.6	0.2	0.04	5.30
17	80.8	80.9	0.1	0.07	5.37
18	77.8	77.9	0.1	0.04	5.41
19	75.3	75.0	-0.3	0.05	5.45
20	72.0	72.0	0.0	0.04	5.49
21	70.0	70.2	0.2	0.01	5.50
22	68.2	68.3	0.1	0.02	5.52
23	66.5	66.7	0.2	0.03	5.55
24	65.0	65.0	0.0	0.01	5.56
25	66.6	66.6	0.0	0.03	5.59
26	72.6	72.1	-0.5	0.11	5.70
27	80.3	80.0	-0.3	0.23	5.93
28	86.1	85.7	-0.4	0.38	6.30
29	90.6	89.8	-0.8	0.50	6.80
30	94.6	94.0	-0.6	0.96	7.76
31	98.1	97.7	-0.4	1.91	9.67
32	101.2	100.5	-0.7	2.83	12.50
33	103.4	102.8	-0.6	2.89	15.39
34	104.9	104.4	-0.5	2.67	18.06
35	105.0	104.6	-0.4	1.95	20.01
36	104.2	103.7	-0.5	1.04	21.05

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	99.5	-1.6	0.53	21.58
38	95.3	94.8	-0.5	0.19	21.77
39	88.8	88.6	-0.2	0.00	21.77
40	84.4	84.4	0	0.03	21.80
41	80.8	81	0.2	-0.03	21.77
42	77.8	77.7	-0.1	0.00	21.77
43	75.3	75.5	0.2	0.03	21.80
44	72	72	0	-0.03	21.77
45	70	70	0	-0.06	21.71
46	68.2	68.2	0	-0.06	21.65
47	66.5	66.6	0.1	-0.03	21.62
48	65	65.1	0.1	-0.03	21.58
49	66.6	66.6	0	0.00	21.58
50	72.6	72.1	-0.5	0.09	21.68
51	80.3	80	-0.3	0.25	21.93
52	86.1	85.7	-0.4	0.41	22.34
53	90.6	90.2	-0.4	0.60	22.94
54	94.6	94	-0.6	1.32	24.26
55	98.1	97.5	-0.6	2.51	26.77
56	101.2	100.6	-0.6	3.65	30.42
57	103.4	102.7	-0.7	3.30	33.72
58	104.9	104.3	-0.6	3.01	36.73
59	105	104.6	-0.4	1.98	38.71
60	104.2	103.6	-0.6	1.22	39.93
61	101.1	99.7	-1.4	0.47	40.41
62	95.3	95	-0.3	0.09	40.50
63	88.8	88.8	0	0.09	40.59
64	84.4	84.5	0.1	-0.09	40.50
65	80.8	81	0.2	-0.09	40.41
66	77.8	77.7	-0.1	0.00	40.41
67	75.3	75.2	-0.1	-0.19	40.22
68	72	72.1	0.1	-0.09	40.12
69	70	69.9	-0.1	-0.09	40.03
70	68.2	68.2	0	-0.09	39.93
71	66.5	66.4	-0.1	0.00	39.93
72	65	65	0	-0.19	39.75

Average Temperature Error (°F): -0.30

Automotive Testing Laboratories, Inc.

Test Date: 9/10/93
Test Fuel: Phase 1
Vehicle: 8

Hour	SHED Temperature, °F			HC, grams		Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative		Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.4	-1.6	--	--	37	101.1	99	-2.1	0.31	10.60
1	66.6	65.9	-0.7	0.07	0.07	38	95.3	95.1	-0.2	0.16	10.75
2	72.6	71.9	-0.7	0.08	0.16	39	88.8	87.8	-1	0.06	10.82
3	80.3	80.0	-0.3	0.11	0.26	40	84.4	84.2	-0.2	0.03	10.85
4	86.1	85.5	-0.6	0.13	0.39	41	80.8	80.7	-0.1	0.03	10.88
5	90.6	90.1	-0.5	0.16	0.55	42	77.8	77.7	-0.1	0.03	10.91
6	94.6	93.2	-1.4	0.17	0.72	43	75.3	75.1	-0.2	0.00	10.91
7	98.1	97.0	-1.1	0.20	0.91	44	72	72	0	0.03	10.94
8	101.2	99.6	-1.6	0.23	1.15	45	70	70.2	0.2	0.03	10.97
9	103.4	102.1	-1.3	0.22	1.37	46	68.2	68.4	0.2	0.09	11.07
10	104.9	103.2	-1.7	0.26	1.63	47	66.5	66.5	0	0.12	11.19
11	105.0	104.5	-0.5	0.21	1.84	48	65	64.9	-0.1	0.19	11.38
12	104.2	103.3	-0.9	0.22	2.05	49	66.6	66.5	-0.1	0.25	11.63
13	101.1	99.2	-1.9	0.20	2.25	50	72.6	72.4	-0.2	0.37	12.00
14	95.3	95.0	-0.3	0.08	2.33	51	80.3	80.1	-0.2	0.44	12.44
15	88.8	88.0	-0.8	0.07	2.40	52	86.1	85.6	-0.5	0.50	12.93
16	84.4	84.3	-0.1	0.07	2.47	53	90.6	87.6	-3	0.53	13.46
17	80.8	80.8	0.0	0.07	2.54	54	94.6	91.6	-3	0.34	13.80
18	77.8	78.1	0.3	0.09	2.63	55	98.1	96.4	-1.7	0.62	14.43
19	75.3	75.2	-0.1	0.16	2.79	56	101.2	99.1	-2.1	1.12	15.55
20	72.0	72.1	0.1	0.23	3.02	57	103.4	102	-1.4	1.96	17.51
21	70.0	70.2	0.2	0.25	3.27	58	104.9	104	-0.9	2.65	20.15
22	68.2	68.0	-0.2	0.32	3.59	59	105	104.2	-0.8	0.81	20.96
23	66.5	66.6	0.1	0.33	3.92	60	104.2	103.4	-0.8	1.24	22.21
24	65.0	65.2	0.2	0.34	4.26	61	101.1	99.2	-1.9	0.12	22.33
25	66.6	66.6	0.0	0.35	4.60	62	95.3	94.2	-1.1	0.16	22.49
26	72.6	72.1	-0.5	0.37	4.97	63	88.8	88.5	-0.3	0.03	22.52
27	80.3	79.5	-0.8	0.38	5.36	64	84.4	84.3	-0.1	0.00	22.52
28	86.1	85.6	-0.5	0.44	5.80	65	80.8	80.7	-0.1	0.00	22.52
29	90.6	90.0	-0.6	0.45	6.24	66	77.8	77.5	-0.3	-0.03	22.49
30	94.6	93.5	-1.1	0.49	6.74	67	75.3	74.8	-0.5	-0.03	22.46
31	98.1	97.6	-0.5	0.36	7.10	68	72	72	0	-0.03	22.43
32	101.2	99.8	-1.4	0.42	7.52	69	70	70.1	0.1	-0.09	22.33
33	103.4	102.4	-1.0	0.46	7.98	70	68.2	68.1	-0.1	0.03	22.36
34	104.9	103.8	-1.1	0.90	8.89	71	66.5	66.4	-0.1	0.00	22.36
35	105.0	104.6	-0.4	0.72	9.60	72	65	65	0	0.03	22.39
36	104.2	103.3	-0.9	0.68	10.29	Average Temperature Error (°F):			-0.64		

Automotive Testing Laboratories, Inc.

Test Date: 9/28/93
Test Fuel: Phase 2
Vehicle: 8

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	65.0	0.0	--	--
1	66.6	66.2	-0.4	0.05	0.05
2	72.6	72.1	-0.5	0.06	0.11
3	80.3	79.7	-0.6	0.07	0.18
4	86.1	85.9	-0.2	0.09	0.27
5	90.6	90.3	-0.3	0.11	0.38
6	94.6	94.0	-0.6	0.13	0.51
7	98.1	97.7	-0.4	0.14	0.65
8	101.2	100.2	-1.0	0.17	0.82
9	103.4	103.1	-0.3	0.17	0.99
10	104.9	104.4	-0.5	0.19	1.18
11	105.0	104.5	-0.5	0.21	1.39
12	104.2	103.8	-0.4	0.19	1.58
13	101.1	99.4	-1.7	0.18	1.76
14	95.3	94.9	-0.4	0.14	1.90
15	88.8	87.0	-1.8	0.11	2.01
16	84.4	84.0	-0.4	0.09	2.10
17	80.8	80.8	0.0	0.07	2.17
18	77.8	77.7	-0.1	0.09	2.27
19	75.3	75.4	0.1	0.09	2.36
20	72.0	72.0	0.0	0.09	2.45
21	70.0	69.9	-0.1	0.08	2.53
22	68.2	68.2	0.0	0.10	2.63
23	66.5	66.5	0.0	-0.01	2.63
24	65.0	65.0	0.0	0.08	2.71
25	66.6	66.6	0.0	0.09	2.81
26	72.6	72.4	-0.2	0.11	2.92
27	80.3	79.8	-0.5	0.18	3.10
28	86.1	85.4	-0.7	0.21	3.30
29	90.6	89.8	-0.8	0.22	3.53
30	94.6	94.2	-0.4	0.24	3.77
31	98.1	97.7	-0.4	0.26	4.03
32	101.2	100.2	-1.0	0.25	4.28
33	103.4	102.9	-0.5	0.29	4.57
34	104.9	104.3	-0.6	0.23	4.81
35	105.0	104.7	-0.3	0.23	5.04
36	104.2	103.7	-0.5	0.22	5.26

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	99.3	-1.8	0.22	5.47
38	95.3	95	-0.3	0.05	5.52
39	88.8	87.2	-1.6	0.11	5.63
40	84.4	84.4	0	-0.01	5.62
41	80.8	80.8	0	0.00	5.62
42	77.8	76.7	-1.1	0.01	5.63
43	75.3	75.3	0	0.00	5.63
44	72	72	0	0.00	5.63
45	70	70	0	0.01	5.64
46	68.2	68.1	-0.1	0.01	5.65
47	66.5	66.5	0	0.03	5.68
48	65	65	0	0.07	5.75
49	66.6	66.6	0	0.07	5.82
50	72.6	72.2	-0.4	0.13	5.95
51	80.3	80.2	-0.1	0.22	6.16
52	86.1	85.7	-0.4	0.28	6.44
53	90.6	90	-0.6	0.30	6.74
54	94.6	94	-0.6	0.34	7.08
55	98.1	97.7	-0.4	0.31	7.39
56	101.2	100.8	-0.4	0.35	7.73
57	103.4	103.1	-0.3	0.19	7.93
58	104.9	104.3	-0.6	0.50	8.43
59	105	104.5	-0.5	0.41	8.83
60	104.2	103.5	-0.7	0.44	9.27
61	101.1	99.4	-1.7	0.25	9.52
62	95.3	94.8	-0.5	0.12	9.64
63	88.8	87	-1.8	0.03	9.67
64	84.4	84.4	0	0.00	9.67
65	80.8	81	0.2	-0.03	9.64
66	77.8	77.8	0	0.00	9.64
67	75.3	75.3	0	-0.12	9.52
68	72	72	0	-0.03	9.49
69	70	69.7	-0.3	-0.03	9.46
70	68.2	68.1	-0.1	-0.03	9.42
71	66.5	66.5	0	-0.03	9.39
72	65	65.1	0.1	0.00	9.39

Average Temperature Error (°F): -0.41

Automotive Testing Laboratories, Inc.

Test Date: 8/17/93
Test Fuel: Base
Vehicle: 9

	SHED Temperature, °F			HC, grams			SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative	Hour	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	63.9	-1.1	--	--	37	101.1	99.6	-1.5	1.38	26.15
1	66.6	66.7	0.1	0.15	0.15	38	95.3	95.2	-0.1	1.00	27.15
2	72.6	72.2	-0.4	0.15	0.30	39	88.8	87.8	-1	0.69	27.84
3	80.3	79.9	-0.4	0.19	0.49	40	84.4	83.8	-0.6	0.44	28.28
4	86.1	85.6	-0.5	0.26	0.75	41	80.8	80.9	0.1	0.35	28.63
5	90.6	90.0	-0.6	0.35	1.10	42	77.8	77.7	-0.1	0.28	28.91
6	94.6	93.9	-0.7	0.49	1.59	43	75.3	75.3	0	0.47	29.38
7	98.1	97.3	-0.8	0.65	2.24	44	72	72	0	0.28	29.67
8	101.2	100.6	-0.6	0.79	3.03	45	70	70	0	0.28	29.95
9	103.4	103.1	-0.3	1.03	4.06	46	68.2	68.1	-0.1	0.19	30.14
10	104.9	104.3	-0.6	1.20	5.26	47	66.5	66.5	0	0.28	30.42
11	105.0	104.8	-0.2	1.30	6.55	48	65	65	0	0.09	30.51
12	104.2	103.9	-0.3	1.36	7.91	49	66.6	66.6	0	0.28	30.79
13	101.1	99.4	-1.7	1.19	9.10	50	72.6	72.2	-0.4	0.28	31.08
14	95.3	94.5	-0.8	0.82	9.92	51	80.3	80.2	-0.1	0.38	31.45
15	88.8	87.3	-1.5	0.66	10.58	52	86.1	85.7	-0.4	0.47	31.92
16	84.4	83.6	-0.8	0.44	11.02	53	90.6	90.2	-0.4	0.56	32.49
17	80.8	80.9	0.1	0.47	11.49	54	94.6	94.1	-0.5	1.03	33.52
18	77.8	77.8	0.0	0.41	11.90	55	98.1	98	-0.1	1.03	34.56
19	75.3	75.3	0.0	0.35	12.24	56	101.2	100.5	-0.7	1.22	35.78
20	72.0	72.0	0.0	0.35	12.59	57	103.4	102.7	-0.7	1.69	37.47
21	70.0	70.1	0.1	0.31	12.90	58	104.9	104.3	-0.6	1.79	39.26
22	68.2	68.0	-0.2	0.25	13.15	59	105	104.4	-0.6	1.98	41.24
23	66.5	66.4	-0.1	0.25	13.40	60	104.2	103.7	-0.5	1.69	42.93
24	65.0	65.0	0.0	0.22	13.62	61	101.1	99.8	-1.3	1.51	44.44
25	66.6	66.7	0.1	0.22	13.84	62	95.3	94.8	-0.5	1.03	45.47
26	72.6	72.3	-0.3	0.28	14.13	63	88.8	87.6	-1.2	0.56	46.03
27	80.3	79.9	-0.4	0.35	14.47	64	84.4	84	-0.4	0.47	46.50
28	86.1	85.8	-0.3	0.53	15.00	65	80.8	80.8	0	0.28	46.79
29	90.6	90.0	-0.6	0.56	15.57	66	77.8	77.8	0	0.38	47.16
30	94.6	93.9	-0.7	0.75	16.32	67	75.3	75.3	0	0.38	47.54
31	98.1	97.8	-0.3	0.94	17.26	68	72	72	0	0.19	47.73
32	101.2	100.4	-0.8	1.07	18.33	69	70	70	0	0.28	48.01
33	103.4	102.9	-0.5	1.35	19.68	70	68.2	68.3	0.1	0.19	48.20
34	104.9	104.5	-0.4	1.63	21.31	71	66.5	66.6	0.1	0.19	48.39
35	105.0	104.7	-0.3	1.79	23.10	72	65	65.1	0.1	0.19	48.57
36	104.2	103.7	-0.5	1.66	24.77	Average Temperature Error (°F):			-0.38		

Automotive Testing Laboratories, Inc.

Test Date: 7/20/93
Test Fuel: Phase 1
Vehicle: 9

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	63.4	-1.6	--	--
1	66.6	66.3	-0.3	0.30	0.30
2	72.6	72.3	-0.3	0.26	0.55
3	80.3	80.2	-0.1	0.30	0.85
4	86.1	85.9	-0.2	0.36	1.21
5	90.6	90.0	-0.6	0.47	1.67
6	94.6	94.0	-0.6	0.61	2.28
7	98.1	97.3	-0.8	0.90	3.18
8	101.2	100.4	-0.8	1.27	4.45
9	103.4	103.1	-0.3	1.56	6.01
10	104.9	104.4	-0.5	1.88	7.89
11	105.0	104.9	-0.1	1.83	9.72
12	104.2	103.9	-0.3	1.92	11.64
13	101.1	100.0	-1.1	1.45	13.09
14	95.3	95.4	0.1	1.29	14.39
15	88.8	87.7	-1.1	0.92	15.30
16	84.4	83.9	-0.5	0.63	15.94
17	80.8	80.9	0.1	0.57	16.50
18	77.8	77.8	0.0	0.47	16.98
19	75.3	75.2	-0.1	0.35	17.32
20	72.0	72.0	0.0	0.38	17.70
21	70.0	70.1	0.1	0.28	17.99
22	68.2	68.2	0.0	0.28	18.27
23	66.5	66.4	-0.1	0.25	18.52
24	65.0	64.9	-0.1	0.19	18.71
25	66.6	66.6	0.0	0.25	18.96
26	72.6	72.1	-0.5	0.28	19.25
27	80.3	79.5	-0.8	0.41	19.66
28	86.1	85.7	-0.4	0.50	20.16
29	90.6	89.8	-0.8	0.57	20.73
30	94.6	94.1	-0.5	0.88	21.62
31	98.1	97.4	-0.7	1.20	22.81
32	101.2	100.6	-0.6	1.36	24.17
33	103.4	102.9	-0.5	1.61	25.78
34	104.9	104.4	-0.5	1.55	27.33
35	105.0	104.8	-0.2	1.99	29.32
36	104.2	103.9	-0.3	1.99	31.30

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
37	101.1	99.6	-1.5	1.61	32.91
38	95.3	95.1	-0.2	1.13	34.05
39	88.8	88.3	-0.5	0.76	34.80
40	84.4	84	-0.4	0.57	35.37
41	80.8	80.6	-0.2	0.57	35.94
42	77.8	77.6	-0.2	0.28	36.22
43	75.3	75.2	-0.1	0.38	36.60
44	72	72	0	0.19	36.79
45	70	70	0	0.28	37.07
46	68.2	68	-0.2	0.09	37.17
47	66.5	66.3	-0.2	0.19	37.36
48	65	65	0	0.19	37.55
49	66.6	66.6	0	0.19	37.74
50	72.6	72.5	-0.1	0.28	38.02
51	80.3	80.3	0	0.38	38.40
52	86.1	86.1	0	0.57	38.97
53	90.6	90.1	-0.5	0.76	39.72
54	94.6	94.2	-0.4	0.85	40.57
55	98.1	97.7	-0.4	1.32	41.90
56	101.2	100.5	-0.7	1.23	43.13
57	103.4	102.7	-0.7	1.70	44.83
58	104.9	104.1	-0.8	1.80	46.63
59	105	102.2	-2.8	1.80	48.42
60	104.2	103.4	-0.8	1.70	50.13
61	101.1	99	-2.1	1.42	51.55
62	95.3	95.3	0	1.13	52.68
63	88.8	87.9	-0.9	0.76	53.44
64	84.4	83.7	-0.7	0.47	53.91
65	80.8	81	0.2	0.47	54.38
66	77.8	78	0.2	0.28	54.67
67	75.3	75.3	0	0.19	54.86
68	72	72.1	0.1	0.19	55.04
69	70	70.3	0.3	0.00	55.04
70	68.2	68.3	0.1	0.19	55.23
71	66.5	66.6	0.1	0.09	55.33
72	65	65	0	0.09	55.42
Average Temperature Error (°F):			-0.39		

Automotive Testing Laboratories, Inc.

Test Date: 10/1/93
Test Fuel: Phase 2
Vehicle: 9

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative	Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	66.4	1.4	--	--	37	101.1	99.2	-1.9	0.62	10.46
1	66.6	66.7	0.1	0.06	0.06	38	95.3	94.5	-0.8	0.56	11.02
2	72.6	73.3	0.7	0.11	0.17	39	88.8	87	-1.8	0.43	11.45
3	80.3	80.1	-0.2	0.09	0.26	40	84.4	83.8	-0.6	0.12	11.57
4	86.1	85.9	-0.2	0.14	0.40	41	80.8	80.8	0	0.22	11.79
5	90.6	90.2	-0.4	0.17	0.57	42	77.8	77.4	-0.4	0.15	11.94
6	94.6	94.1	-0.5	0.20	0.78	43	75.3	75.7	0.4	0.22	12.16
7	98.1	97.8	-0.3	0.25	1.02	44	72	72	0	0.12	12.28
8	101.2	100.5	-0.7	0.30	1.32	45	70	70.1	0.1	0.15	12.44
9	103.4	103.0	-0.4	0.35	1.67	46	68.2	68	-0.2	0.12	12.56
10	104.9	104.1	-0.8	0.39	2.07	47	66.5	66.5	0	0.09	12.65
11	105.0	104.7	-0.3	0.48	2.55	48	65	65	0	0.12	12.78
12	104.2	103.6	-0.6	0.33	2.88	49	66.6	66.4	-0.2	0.15	12.93
13	101.1	99.0	-2.1	0.41	3.29	50	72.6	72.3	-0.3	0.15	13.09
14	95.3	94.7	-0.6	0.35	3.64	51	80.3	80.2	-0.1	0.28	13.36
15	88.8	87.0	-1.8	0.25	3.89	52	86.1	85.6	-0.5	0.37	13.74
16	84.4	83.9	-0.5	0.20	4.09	53	90.6	90	-0.6	0.34	14.08
17	80.8	80.8	0.0	0.19	4.29	54	94.6	93.9	-0.7	0.46	14.54
18	77.8	77.1	-0.7	0.17	4.46	55	98.1	97.2	-0.9	0.56	15.09
19	75.3	75.4	0.1	0.14	4.60	56	101.2	100.4	-0.8	0.65	15.74
20	72.0	71.9	-0.1	0.14	4.73	57	103.4	102.9	-0.5	0.71	16.45
21	70.0	69.8	-0.2	0.10	4.84	58	104.9	104.1	-0.8	0.93	17.38
22	68.2	68.2	0.0	0.13	4.97	59	105	104.2	-0.8	0.90	18.28
23	66.5	66.3	-0.2	0.09	5.06	60	104.2	103.7	-0.5	0.93	19.20
24	65.0	65.0	0.0	0.10	5.16	61	101.1	99.2	-1.9	0.80	20.01
25	66.6	66.3	-0.3	0.09	5.25	62	95.3	95.1	-0.2	0.62	20.62
26	72.6	72.0	-0.6	0.14	5.39	63	88.8	88.2	-0.6	0.43	21.06
27	80.3	80.2	-0.1	0.21	5.60	64	84.4	84.2	-0.2	0.34	21.40
28	86.1	85.9	-0.2	0.26	5.86	65	80.8	80.8	0	0.22	21.61
29	90.6	90.1	-0.5	0.30	6.16	66	77.8	77.8	0	0.15	21.77
30	94.6	93.8	-0.8	0.35	6.51	67	75.3	75.4	0.1	0.19	21.95
31	98.1	97.5	-0.6	0.40	6.91	68	72	72	0	0.09	22.04
32	101.2	100.7	-0.5	0.46	7.37	69	70	70.1	0.1	0.09	22.14
33	103.4	102.8	-0.6	0.43	7.81	70	68.2	68.2	0	0.12	22.26
34	104.9	104.2	-0.7	0.65	8.45	71	66.5	66.6	0.1	0.06	22.32
35	105.0	104.6	-0.4	0.68	9.13	72	65	65	0	0.12	22.45
36	104.2	103.7	-0.5	0.71	9.84	Average Temperature Error (°F):			-0.39		

Automotive Testing Laboratories, Inc.

Test Date: 10/8/93
Test Fuel: SBE
Vehicle: 9

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	64.4	-0.6	--	--
1	66.6	66.6	0.0	0.34	0.34
2	72.6	----	----	0.34	0.68
3	80.3	----	----	0.36	1.04
4	86.1	----	----	0.48	1.52
5	90.6	89.6	-1.0	0.64	2.16
6	94.6	93.3	-1.3	0.71	2.87
7	98.1	97.4	-0.7	1.04	3.91
8	101.2	100.1	-1.1	1.23	5.14
9	103.4	102.6	-0.8	1.45	6.59
10	104.9	103.9	-1.0	1.67	8.26
11	105.0	104.6	-0.4	1.64	9.90
12	104.2	103.8	-0.4	1.68	11.58
13	101.1	100.6	-0.5	1.56	13.13
14	95.3	94.8	-0.5	1.18	14.32
15	88.8	88.7	-0.1	0.81	15.13
16	84.4	84.1	-0.3	0.68	15.81
17	80.8	80.8	0.0	0.50	16.31
18	77.8	77.6	-0.2	0.47	16.78
19	75.3	75.3	0.0	0.37	17.15
20	72.0	72.1	0.1	0.40	17.55
21	70.0	70.0	0.0	0.28	17.83
22	68.2	68.5	0.3	0.28	18.12
23	66.5	66.7	0.2	0.22	18.33
24	65.0	65.0	0.0	0.25	18.58
25	66.6	66.5	-0.1	0.22	18.80
26	72.6	72.0	-0.6	0.34	19.14
27	80.3	79.8	-0.5	0.47	19.61
28	86.1	85.7	-0.4	0.65	20.26
29	90.6	89.8	-0.8	0.81	21.07
30	94.6	93.7	-0.9	0.84	21.91
31	98.1	97.5	-0.6	1.15	23.06
32	101.2	100.2	-1.0	1.34	24.40
33	103.4	102.8	-0.6	1.56	25.96
34	104.9	104.1	-0.8	2.47	28.43
35	105.0	104.6	-0.4	1.68	30.11
36	104.2	103.5	-0.7	1.59	31.70

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	100.4	-0.7	1.50	33.20
38	95.3	94.9	-0.4	1.03	34.23
39	88.8	88.3	-0.5	0.75	34.97
40	84.4	84.4	0	0.56	35.54
41	80.8	80.6	-0.2	0.28	35.82
42	77.8	77.8	0	0.47	36.28
43	75.3	75.4	0.1	0.28	36.56
44	72	72.1	0.1	0.28	36.84
45	70	70.1	0.1	0.09	36.94
46	68.2	68.3	0.1	0.19	37.13
47	66.5	66.5	0	0.00	37.13
48	65	65.1	0.1	-0.09	37.03
49	66.6	66.6	0	0.56	37.59
50	72.6	71.6	-1	0.09	37.69
51	80.3	80.2	-0.1	0.65	38.34
52	86.1	85.6	-0.5	0.75	39.09
53	90.6	90.4	-0.2	0.84	39.93
54	94.6	93.7	-0.9	1.03	40.96
55	98.1	97.4	-0.7	1.12	42.08
56	101.2	100	-1.2	1.40	43.48
57	103.4	102.6	-0.8	1.50	44.98
58	104.9	103.9	-1	1.59	46.57
59	105	104.6	-0.4	1.68	48.25
60	104.2	103.7	-0.5	1.59	49.84
61	101.1	100.5	-0.6	1.50	51.34
62	95.3	94.6	-0.7	1.03	52.37
63	88.8	88.7	-0.1	0.47	52.84
64	84.4	84.5	0.1	0.56	53.40
65	80.8	80.8	0	0.37	53.77
66	77.8	77.8	0	0.28	54.05
67	75.3	75.5	0.2	0.09	54.15
68	72	72.2	0.2	0.19	54.33
69	70	70.1	0.1	0.09	54.43
70	68.2	68.1	-0.1	0.00	54.43
71	66.5	66.3	-0.2	0.00	54.43
72	65	65	0	0.09	54.52

Average Temperature Error (°F): -0.35

Automotive Testing Laboratories, Inc.

Test Date: 10/28/93
Test Fuel: Base
Vehicle: 10

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative	Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	63.0	-2.0	--	--	37	101.1	100.7	-0.4	1.25	89.04
1	66.6	66.0	-0.6	0.44	0.44	38	95.3	95.4	0.1	0.94	89.98
2	72.6	72.7	0.1	0.49	0.93	39	88.8	88.4	-0.4	-0.31	89.66
3	80.3	80.1	-0.2	0.68	1.61	40	84.4	84.6	0.2	0.00	89.66
4	86.1	85.7	-0.4	0.57	2.18	41	80.8	80.6	-0.2	-0.31	89.35
5	90.6	90.6	0.0	3.03	5.22	42	77.8	78	0.2	0.00	89.35
6	94.6	94.2	-0.4	5.31	10.53	43	75.3	75.2	-0.1	-0.31	89.04
7	98.1	97.7	-0.4	5.66	16.19	44	72	72	0	-0.31	88.73
8	101.2	100.1	-1.1	5.88	22.07	45	70	69.7	-0.3	0.00	88.73
9	103.4	102.9	-0.5	6.70	28.76	46	68.2	68.3	0.1	0.00	88.73
10	104.9	104.1	-0.8	5.98	34.74	47	66.5	66.6	0.1	0.00	88.73
11	105.0	104.3	-0.7	4.86	39.60	48	65	65.3	0.3	0.00	88.73
12	104.2	103.7	-0.5	3.27	42.87	49	66.6	67.1	0.5	0.31	89.04
13	101.1	100.5	-0.6	1.68	44.55	50	72.6	72.4	-0.2	0.31	89.35
14	95.3	94.7	-0.6	0.75	45.30	51	80.3	80.1	-0.2	0.62	89.98
15	88.8	89.0	0.2	0.37	45.67	52	86.1	86	-0.1	0.62	90.60
16	84.4	84.5	0.1	0.09	45.77	53	90.6	89.9	-0.7	3.12	93.72
17	80.8	80.9	0.1	0.09	45.86	54	94.6	94.2	-0.4	4.68	98.40
18	77.8	77.6	-0.2	0.09	45.95	55	98.1	97.2	-0.9	5.61	104.01
19	75.3	75.4	0.1	0.00	45.95	56	101.2	100.3	-0.9	5.61	109.63
20	72.0	72.0	0.0	0.00	45.95	57	103.4	103.1	-0.3	5.61	115.24
21	70.0	70.2	0.2	0.19	46.14	58	104.9	104.3	-0.6	5.93	121.17
22	68.2	68.2	0.0	0.09	46.23	59	105	104.7	-0.3	4.37	125.54
23	66.5	66.4	-0.1	0.28	46.51	60	104.2	103.8	-0.4	2.50	128.03
24	65.0	65.2	0.2	0.47	46.98	61	101.1	100.7	-0.4	1.25	129.28
25	66.6	66.5	-0.1	0.37	47.36	62	95.3	94.5	-0.8	0.62	129.90
26	72.6	72.2	-0.4	0.47	47.82	63	88.8	88.3	-0.5	0.00	129.90
27	80.3	79.9	-0.4	0.56	48.38	64	84.4	84.2	-0.2	-0.31	129.59
28	86.1	86.5	0.4	0.56	48.94	65	80.8	80.8	0	-0.94	128.65
29	90.6	90.0	-0.6	2.90	51.84	66	77.8	77.8	0	-0.31	128.34
30	94.6	94.2	-0.4	4.86	56.70	67	75.3	75.3	0	-0.31	128.03
31	98.1	97.6	-0.5	5.89	62.58	68	72	72	0	-0.62	127.41
32	101.2	100.4	-0.8	6.26	68.84	69	70	70	0	0.00	127.41
33	103.4	102.6	-0.8	5.98	74.82	70	68.2	68.2	0	-0.31	127.09
34	104.9	104.2	-0.7	5.17	80.00	71	66.5	66.6	0.1	0.00	127.09
35	105.0	104.5	-0.5	4.68	84.67	72	65	65.2	0.2	0.00	127.09
36	104.2	103.5	-0.7	3.12	87.79	Average Temperature Error (°F):			-0.28		

Automotive Testing Laboratories, Inc.

Test Date: 10-21-93
Test Fuel: Phase 1
Vehicle: 10

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	64.3	-0.7	--	--
1	66.6	66.1	-0.5	0.29	0.29
2	72.6	71.4	-1.2	0.27	0.56
3	80.3	80.0	-0.3	0.32	0.88
4	86.1	85.4	-0.7	0.42	1.30
5	90.6	89.7	-0.9	2.85	4.15
6	94.6	92.9	-1.7	3.96	8.11
7	98.1	96.3	-1.8	4.34	12.45
8	101.2	99.0	-2.2	4.68	17.13
9	103.4	102.0	-1.4	5.38	22.51
10	104.9	102.8	-2.1	4.40	26.91
11	105.0	104.2	-0.8	4.70	31.61
12	104.2	103.3	-0.9	2.66	34.27
13	101.1	100.4	-0.7	1.24	35.51
14	95.3	95.3	0.0	0.57	36.08
15	88.8	89.0	0.2	0.19	36.27
16	84.4	84.5	0.1	0.19	36.46
17	80.8	81.2	0.4	-0.10	36.36
18	77.8	77.9	0.1	0.19	36.55
19	75.3	75.3	0.0	0.10	36.65
20	72.0	72.0	0.0	-0.10	36.55
21	70.0	70.2	0.2	0.00	36.55
22	68.2	68.2	0.0	0.00	36.55
23	66.5	66.4	-0.1	-0.10	36.46
24	65.0	65.3	0.3	0.00	36.46
25	66.6	66.2	-0.4	0.00	36.46
26	72.6	72.1	-0.5	0.19	36.65
27	80.3	79.7	-0.6	0.67	37.31
28	86.1	85.4	-0.7	2.19	39.50
29	90.6	89.8	-0.8	4.28	43.78
30	94.6	93.2	-1.4	4.47	48.25
31	98.1	97.5	-0.6	4.85	53.09
32	101.2	99.5	-1.7	5.23	58.32
33	103.4	102.7	-0.7	5.89	64.22
34	104.9	103.3	-1.6	4.18	68.40
35	105.0	104.2	-0.8	3.42	71.82
36	104.2	103.3	-0.9	2.19	74.01

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	100.2	-0.9	1.14	75.15
38	95.3	95.1	-0.2	0.38	75.53
39	88.8	88.6	-0.2	0.10	75.62
40	84.4	84.3	-0.1	-0.10	75.53
41	80.8	81.1	0.3	-0.19	75.34
42	77.8	77.6	-0.2	-0.10	75.24
43	75.3	75.5	0.2	0.00	75.24
44	72	72.3	0.3	-0.19	75.05
45	70	70	0	-0.10	74.96
46	68.2	68.3	0.1	-0.19	74.77
47	66.5	66.6	0.1	-0.19	74.58
48	65	65.3	0.3	-0.29	74.29
49	66.6	66.7	0.1	-0.10	74.20
50	72.6	72.1	-0.5	0.10	74.29
51	80.3	79.6	-0.7	0.67	74.96
52	86.1	85.2	-0.9	2.38	77.34
53	90.6	89.8	-0.8	3.49	80.82
54	94.6	93.1	-1.5	4.44	85.27
55	98.1	97.8	-0.3	5.40	90.66
56	101.2	100.5	-0.7	5.40	96.06
57	103.4	102.7	-0.7	6.35	102.41
58	104.9	103.5	-1.4	3.17	105.58
59	105	104.3	-0.7	3.49	109.07
60	104.2	103.5	-0.7	1.90	110.98
61	101.1	100.4	-0.7	0.95	111.93
62	95.3	95	-0.3	0.32	112.25
63	88.8	88.7	-0.1	0.32	112.56
64	84.4	84.5	0.1	0.00	112.56
65	80.8	80.9	0.1	-0.63	111.93
66	77.8	77.7	-0.1	-0.32	111.61
67	75.3	75.2	-0.1	0.00	111.61
68	72	72.1	0.1	-0.63	110.98
69	70	69.9	-0.1	-0.32	110.66
70	68.2	68.3	0.1	-0.63	110.02
71	66.5	66.6	0.1	0.00	110.02
72	65	65	0	-0.63	109.39
Average Temperature Error (°F):			-0.48		

Automotive Testing Laboratories, Inc.

Test Date: 10/5/93
Test Fuel: Phase 2
Vehicle: 10

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	65.0	0.0	--	--
1	66.6	66.0	-0.6	0.27	0.27
2	72.6	72.3	-0.3	0.25	0.52
3	80.3	79.9	-0.4	0.28	0.80
4	86.1	85.7	-0.4	0.34	1.14
5	90.6	90.3	-0.3	0.40	1.54
6	94.6	93.6	-1.0	1.03	2.56
7	98.1	97.4	-0.7	3.06	5.62
8	101.2	99.8	-1.4	3.28	8.90
9	103.4	102.6	-0.8	3.33	12.23
10	104.9	103.7	-1.2	3.36	15.58
11	105.0	104.6	-0.4	2.95	18.53
12	104.2	103.5	-0.7	2.32	20.86
13	101.1	99.2	-1.9	0.78	21.64
14	95.3	95.1	-0.2	0.28	21.92
15	88.8	87.9	-0.9	0.22	22.14
16	84.4	84.4	0.0	0.09	22.24
17	80.8	80.6	-0.2	-0.16	22.08
18	77.8	77.7	-0.1	0.06	22.14
19	75.3	75.3	0.0	0.00	22.14
20	72.0	72.0	0.0	0.06	22.21
21	70.0	70.0	0.0	0.06	22.27
22	68.2	68.5	0.3	-0.03	22.24
23	66.5	66.5	0.0	0.03	22.27
24	65.0	65.1	0.1	0.00	22.27
25	66.6	66.6	0.0	0.03	22.30
26	72.6	72.5	-0.1	0.35	22.64
27	80.3	80.0	-0.3	0.41	23.05
28	86.1	85.7	-0.4	1.38	24.43
29	90.6	90.1	-0.5	2.32	26.76
30	94.6	93.6	-1.0	4.03	30.78
31	98.1	97.2	-0.9	3.11	33.89
32	101.2	100.2	-1.0	4.15	38.04
33	103.4	102.9	-0.5	3.96	42.00
34	104.9	104.0	-0.9	3.39	45.40
35	105.0	104.7	-0.3	3.21	48.60
36	104.2	103.9	-0.3	1.98	50.58

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
37	101.1	99.3	-1.8	0.75	51.33
38	95.3	94.7	-0.6	0.19	51.52
39	88.8	87.7	-1.1	-0.09	51.43
40	84.4	84.3	-0.1	-0.09	51.33
41	80.8	80.8	0	-0.09	51.24
42	77.8	77.9	0.1	-0.57	50.68
43	75.3	75.2	-0.1	-0.19	50.49
44	72	72	0	-0.19	50.30
45	70	70	0	-0.19	50.11
46	68.2	68	-0.2	-0.19	49.92
47	66.5	66.7	0.2	-0.09	49.83
48	65	65.2	0.2	-0.19	49.64
49	66.6	66.6	0	-0.09	49.54
50	72.6	72.2	-0.4	0.19	49.73
51	80.3	79.5	-0.8	0.57	50.30
52	86.1	85.5	-0.6	1.32	51.62
53	90.6	90.2	-0.4	2.55	54.16
54	94.6	93.6	-1	3.02	57.18
55	98.1	97.6	-0.5	3.49	60.67
56	101.2	100.1	-1.1	3.58	64.25
57	103.4	102.9	-0.5	3.87	68.12
58	104.9	104.4	-0.5	3.49	71.60
59	105	104.9	-0.1	3.02	74.62
60	104.2	103.6	-0.6	2.17	76.79
61	101.1	100	-1.1	1.04	77.83
62	95.3	92	-3.3	0.19	78.01
63	88.8	88.8	0	-0.19	77.83
64	84.4	84.4	0	-0.09	77.73
65	80.8	81	0.2	-0.66	77.07
66	77.8	77.8	0	-0.28	76.79
67	75.3	75.3	0	-0.94	75.85
68	72	72.2	0.2	-0.28	75.56
69	70	70.3	0.3	-0.09	75.47
70	68.2	68.4	0.2	-0.47	75.00
71	66.5	66.4	-0.1	-0.28	74.71
72	65	65	0	-0.19	74.53
Average Temperature Error (°F):			-0.42		

Automotive Testing Laboratories, Inc.

Test Date: 12/27/93
Test Fuel: Base
Vehicle: 11

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	63.7	-1.3	--	--
1	66.6	66.4	-0.2	0.93	0.93
2	72.6	72.6	0.0	0.84	1.77
3	80.3	79.9	-0.4	0.85	2.62
4	86.1	85.6	-0.5	0.64	3.27
5	90.6	90.1	-0.5	0.36	3.63
6	94.6	93.7	-0.9	0.45	4.08
7	98.1	96.7	-1.4	0.52	4.60
8	101.2	99.1	-2.1	0.53	5.14
9	103.4	101.3	-2.1	0.58	5.72
10	104.9	103.1	-1.8	0.59	6.31
11	105.0	104.0	-1.0	0.66	6.97
12	104.2	103.6	-0.6	0.62	7.59
13	101.1	100.7	-0.4	0.53	8.12
14	95.3	95.1	-0.2	0.41	8.53
15	88.8	88.5	-0.3	0.26	8.79
16	84.4	84.3	-0.1	0.17	8.96
17	80.8	81.2	0.4	-0.11	8.85
18	77.8	78.1	0.3	0.06	8.91
19	75.3	75.3	0.0	0.06	8.98
20	72.0	72.0	0.0	0.03	9.01
21	70.0	70.0	0.0	0.06	9.07
22	68.2	68.3	0.1	0.06	9.14
23	66.5	66.5	0.0	0.00	9.14
24	65.0	65.0	0.0	0.03	9.17
25	66.6	66.6	0.0	0.03	9.20
26	72.6	72.2	-0.4	0.16	9.36
27	80.3	79.7	-0.6	0.45	9.80
28	86.1	85.7	-0.4	0.54	10.34
29	90.6	90.1	-0.5	0.70	11.04
30	94.6	93.9	-0.7	0.89	11.94
31	98.1	96.9	-1.2	0.76	12.70
32	101.2	99.2	-2.0	0.86	13.56
33	103.4	102.8	-0.6	1.02	14.57
34	104.9	103.4	-1.5	1.21	15.78
35	105.0	104.6	-0.4	1.24	17.02
36	104.2	103.8	-0.4	0.99	18.01

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	100.7	-0.4	0.57	18.58
38	95.3	95.6	0.3	0.54	19.12
39	88.8	88.8	0	0.25	19.38
40	84.4	84.7	0.3	0.13	19.50
41	80.8	81	0.2	-0.10	19.41
42	77.8	78.1	0.3	0.00	19.41
43	75.3	75.5	0.2	-0.06	19.34
44	72	72	0	0.00	19.34
45	70	70	0	-0.03	19.31
46	68.2	68.2	0	-0.06	19.25
47	66.5	66.5	0	-0.03	19.22
48	65	65	0	-0.06	19.15
49	66.6	66.6	0	-0.03	19.12
50	72.6	72.3	-0.3	0.16	19.28
51	80.3	80	-0.3	0.89	20.17
52	86.1	85.7	-0.4	1.53	21.70
53	90.6	90.1	-0.5	1.75	23.45
54	94.6	93.9	-0.7	1.91	25.35
55	98.1	97	-1.1	2.35	27.71
56	101.2	99.3	-1.9	3.12	30.83
57	103.4	101.8	-1.6	2.39	33.22
58	104.9	103.1	-1.8	2.87	36.08
59	105	104	-1	2.49	38.57
60	104.2	103.5	-0.7	1.72	40.29
61	101.1	100.8	-0.3	0.86	41.15
62	95.3	95.5	0.2	0.38	41.53
63	88.8	88.9	0.1	0.19	41.72
64	84.4	84.4	0	0.10	41.82
65	80.8	81	0.2	0.10	41.92
66	77.8	77.7	-0.1	-0.19	41.72
67	75.3	75.5	0.2	-0.19	41.53
68	72	72	0	-0.29	41.25
69	70	70	0	0.00	41.25
70	68.2	68.2	0	-0.29	40.96
71	66.5	66.5	0	-0.19	40.77
72	65	65	0	-0.19	40.58

Average Temperature Error (°F): -0.42

Automotive Testing Laboratories, Inc.

Test Date: 1/25/94
Test Fuel: Phase 1
Vehicle: 11

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.3	-0.7	--	--
1	66.6	66.6	0.0	0.65	0.65
2	72.6	72.5	-0.1	0.62	1.26
3	80.3	79.7	-0.6	0.65	1.91
4	86.1	85.5	-0.6	0.66	2.57
5	90.6	90.1	-0.5	0.75	3.33
6	94.6	93.9	-0.7	0.53	3.86
7	98.1	96.6	-1.5	0.48	4.34
8	101.2	98.7	-2.5	0.62	4.96
9	103.4	100.9	-2.5	0.45	5.41
10	104.9	102.2	-2.7	0.59	5.99
11	105.0	103.7	-1.3	0.61	6.61
12	104.2	102.8	-1.4	0.64	7.25
13	101.1	100.0	-1.1	0.26	7.51
14	95.3	94.9	-0.4	0.40	7.91
15	88.8	88.8	0.0	0.22	8.13
16	84.4	84.4	0.0	0.16	8.28
17	80.8	81.0	0.2	0.09	8.37
18	77.8	77.9	0.1	0.06	8.44
19	75.3	75.4	0.1	0.06	8.50
20	72.0	72.1	0.1	0.03	8.53
21	70.0	70.0	0.0	0.00	8.53
22	68.2	68.3	0.1	0.03	8.56
23	66.5	66.6	0.1	0.00	8.56
24	65.0	65.3	0.3	0.03	8.59
25	66.6	66.6	0.0	0.03	8.62
26	72.6	72.5	-0.1	0.19	8.81
27	80.3	79.6	-0.7	0.34	9.15
28	86.1	85.6	-0.5	0.50	9.64
29	90.6	90.1	-0.5	0.56	10.20
30	94.6	94.6	0.0	0.62	10.82
31	98.1	97.5	-0.6	0.71	11.54
32	101.2	101.2	0.0	0.71	12.25
33	103.4	102.6	-0.8	0.78	13.02
34	104.9	104.3	-0.6	0.90	13.92
35	105.0	104.6	-0.4	0.78	14.70
36	104.2	103.5	-0.7	0.74	15.44
37	101.1	100.3	-0.8	0.56	16.00
38	95.3	95	-0.3	0.37	16.37
39	88.8	88.9	0.1	0.19	16.56
40	84.4	84.4	0	0.06	16.62
41	80.8	80.9	0.1	0.00	16.62
42	77.8	78.1	0.3	0.00	16.62
43	75.3	75.3	0	-0.03	16.59
44	72	72.1	0.1	-0.03	16.56
45	70	70.1	0.1	-0.06	16.50
46	68.2	68.2	0	-0.06	16.43
47	66.5	66.5	0	-0.09	16.34
48	65	65	0	0.00	16.34
49	66.6	66.6	0	0.03	16.37
50	72.6	72.4	-0.2	0.22	16.59
51	80.3	80.2	-0.1	0.78	17.36
52	86.1	85.8	-0.3	1.21	18.57
53	90.6	90.4	-0.2	1.05	19.63
54	94.6	93.8	-0.8	1.33	20.96
55	98.1	97.6	-0.5	1.58	22.54
56	101.2	101.2	0	1.74	24.28
57	103.4	102.7	-0.7	1.86	26.14
58	104.9	105.1	0.2	2.79	28.93
59	105	104.7	-0.3	1.68	30.60
60	104.2	103.8	-0.4	1.12	31.72
61	101.1	102	0.9	0.84	32.56
62	95.3	95.4	0.1	0.65	33.21
63	88.8	88.7	-0.1	0.00	33.21
64	84.4	84.4	0	0.09	33.31
65	80.8	81.1	0.3	-0.09	33.21
66	77.8	77.9	0.1	-0.09	33.12
67	75.3	75.4	0.1	0.00	33.12
68	72	72.1	0.1	-0.19	32.93
69	70	70	0	-0.19	32.75
70	68.2	68.3	0.1	-0.19	32.56
71	66.5	66.6	0.1	-0.19	32.38
72	65	65	0	-0.19	32.19

Average Temperature Error (°F): -0.31

Automotive Testing Laboratories, Inc.

Test Date: 1/07/94
Test Fuel: Phase 2
Vehicle: 11

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	63.5	-1.5	--	--
1	66.6	66.6	0.0	0.43	0.43
2	72.6	72.1	-0.5	0.32	0.75
3	80.3	79.8	-0.5	0.31	1.05
4	86.1	85.7	-0.4	0.36	1.41
5	90.6	90.0	-0.6	0.40	1.81
6	94.6	93.9	-0.7	0.44	2.25
7	98.1	97.4	-0.7	0.39	2.65
8	101.2	99.5	-1.7	0.52	3.16
9	103.4	102.0	-1.4	0.52	3.68
10	104.9	103.4	-1.5	0.59	4.27
11	105.0	104.5	-0.5	0.61	4.88
12	104.2	103.5	-0.7	0.60	5.48
13	101.1	100.4	-0.7	0.55	6.03
14	95.3	94.9	-0.4	0.44	6.47
15	88.8	89.0	0.2	0.28	6.75
16	84.4	84.6	0.2	0.18	6.93
17	80.8	80.8	0.0	0.16	7.09
18	77.8	77.7	-0.1	0.10	7.19
19	75.3	75.0	-0.3	0.10	7.29
20	72.0	72.0	0.0	0.11	7.41
21	70.0	70.1	0.1	0.02	7.43
22	68.2	68.1	-0.1	0.06	7.48
23	66.5	66.4	-0.1	0.03	7.51
24	65.0	64.9	-0.1	0.06	7.57
25	66.6	66.3	-0.3	0.06	7.62
26	72.6	72.1	-0.5	0.18	7.80
27	80.3	80.0	-0.3	0.08	7.88
28	86.1	85.8	-0.3	0.37	8.26
29	90.6	89.8	-0.8	0.44	8.69
30	94.6	94.0	-0.6	0.50	9.19
31	98.1	97.2	-0.9	0.53	9.72
32	101.2	99.6	-1.6	0.53	10.25
33	103.4	102.0	-1.4	0.62	10.88
34	104.9	103.4	-1.5	0.59	11.47
35	105.0	104.4	-0.6	0.66	12.13
36	104.2	103.5	-0.7	0.59	12.72

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	100.6	-0.5	0.47	13.19
38	95.3	95.1	-0.2	0.41	13.60
39	88.8	88.9	0.1	0.12	13.72
40	84.4	84.5	0.1	0.06	13.79
41	80.8	80.8	0	0.00	13.79
42	77.8	77.7	-0.1	0.00	13.79
43	75.3	75.2	-0.1	0.00	13.79
44	72	72	0	-0.06	13.72
45	70	69.9	-0.1	-0.06	13.66
46	68.2	68.1	-0.1	-0.03	13.63
47	66.5	66.7	0.2	-0.12	13.50
48	65	64.9	-0.1	-0.03	13.47
49	66.6	66.7	0.1	-0.03	13.44
50	72.6	72.3	-0.3	0.12	13.57
51	80.3	79.8	-0.5	0.34	13.91
52	86.1	85.6	-0.5	0.44	14.35
53	90.6	90.1	-0.5	0.53	14.88
54	94.6	94	-0.6	0.62	15.50
55	98.1	97.5	-0.6	0.59	16.10
56	101.2	99.8	-1.4	0.69	16.79
57	103.4	102.2	-1.2	0.69	17.47
58	104.9	103.4	-1.5	0.69	18.16
59	105	104.5	-0.5	0.69	18.85
60	104.2	103.8	-0.4	0.84	19.69
61	101.1	100.7	-0.4	0.47	20.16
62	95.3	95	-0.3	0.16	20.32
63	88.8	88.6	-0.2	0.06	20.38
64	84.4	84.5	0.1	-0.06	20.32
65	80.8	80.8	0	-0.09	20.22
66	77.8	78	0.2	-0.12	20.10
67	75.3	75.4	0.1	-0.09	20.00
68	72	72	0	-0.09	19.91
69	70	70	0	-0.16	19.75
70	68.2	68.2	0	-0.09	19.66
71	66.5	66.5	0	-0.22	19.44
72	65	65	0	-0.09	19.35

Average Temperature Error (°F):	-0.42

Automotive Testing Laboratories, Inc.

Test Date: 10/12/93
Test Fuel: Basc
Vehicle: 12

	SHED Temperature, °F			HC, grams			SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative	Hour	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.1	-0.9	--	--	37	101.1	100.1	-1	1.22	54.95
1	66.6	65.9	-0.7	0.13	0.13	38	95.3	94.9	-0.4	0.66	55.61
2	72.6	72.1	-0.5	0.16	0.29	39	88.8	88.4	-0.4	-0.38	55.23
3	80.3	80.2	-0.1	0.21	0.50	40	84.4	84.7	0.3	0.09	55.32
4	86.1	86.0	-0.1	0.28	0.78	41	80.8	80.5	-0.3	-0.09	55.23
5	90.6	90.1	-0.5	0.29	1.07	42	77.8	78.1	0.3	0.47	55.70
6	94.6	93.3	-1.3	1.43	2.50	43	75.3	75.1	-0.2	-0.09	55.61
7	98.1	97.4	-0.7	3.50	6.00	44	72	71.9	-0.1	0.00	55.61
8	101.2	99.6	-1.6	4.13	10.13	45	70	70	0	-0.19	55.42
9	103.4	102.0	-1.4	3.75	13.89	46	68.2	68.1	-0.1	-0.19	55.23
10	104.9	103.2	-1.7	3.88	17.77	47	66.5	66.6	0.1	-0.09	55.14
11	105.0	104.3	-0.7	3.32	21.08	48	65	65	0	0.00	55.14
12	104.2	102.9	-1.3	2.38	23.46	49	66.6	66.6	0	-0.09	55.04
13	101.1	99.7	-1.4	1.16	24.62	50	72.6	72.6	0	0.00	55.04
14	95.3	94.6	-0.7	0.78	25.40	51	80.3	79.7	-0.6	0.28	55.32
15	88.8	88.0	-0.8	0.25	25.65	52	86.1	85.7	-0.4	0.38	55.70
16	84.4	84.6	0.2	0.25	25.90	53	90.6	90.1	-0.5	0.75	56.45
17	80.8	81.1	0.3	0.09	25.99	54	94.6	93.3	-1.3	3.10	59.55
18	77.8	77.2	-0.6	0.13	26.12	55	98.1	97	-1.1	3.57	63.13
19	75.3	75.4	0.1	0.03	26.15	56	101.2	99.4	-1.8	4.32	67.45
20	72.0	72.0	0.0	0.06	26.21	57	103.4	102.1	-1.3	4.14	71.59
21	70.0	70.0	0.0	0.00	26.21	58	104.9	104.9	0	4.51	76.10
22	68.2	68.4	0.2	0.00	26.21	59	105	104.4	-0.6	2.44	78.54
23	66.5	66.6	0.1	0.00	26.21	60	104.2	103.1	-1.1	2.44	80.98
24	65.0	65.0	0.0	-0.09	26.12	61	101.1	100.2	-0.9	1.13	82.11
25	66.6	66.6	0.0	0.00	26.12	62	95.3	95.3	0	-0.18	81.93
26	72.6	72.3	-0.3	0.06	26.18	63	88.8	88.4	-0.4	0.94	82.87
27	80.3	79.7	-0.6	0.22	26.40	64	84.4	84.3	-0.1	-0.94	81.93
28	86.1	85.7	-0.4	0.34	26.75	65	80.8	89.9	9.1	-0.31	81.62
29	90.6	90.1	-0.5	1.79	28.54	66	77.8	77.7	-0.1	0.00	81.62
30	94.6	93.4	-1.2	3.20	31.73	67	75.3	75.3	0	-0.63	80.99
31	98.1	97.2	-0.9	3.67	35.40	68	72	72	0	0.31	81.30
32	101.2	99.4	-1.8	4.32	39.72	69	70	70.2	0.2	-0.31	80.99
33	103.4	101.9	-1.5	4.51	44.23	70	68.2	67.9	-0.3	0.00	80.99
34	104.9	103.0	-1.9	3.76	47.99	71	66.5	66.5	0	-0.31	80.67
35	105.0	104.5	-0.5	3.29	51.28	72	65	65	0	0.00	80.67
36	104.2	103.1	-1.1	2.44	53.73	Average Temperature Error (°F):			-0.38		

Automotive Testing Laboratories, Inc.

Test Date: 8/13/93
Test Fuel: Phase 1
Vehicle: 12

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	64.6	-0.4	--	--
1	66.6	66.6	0.0	0.21	0.21
2	72.6	67.5	-5.1	0.19	0.39
3	80.3	79.7	-0.6	0.23	0.62
4	86.1	85.8	-0.3	0.38	0.99
5	90.6	90.0	-0.6	0.52	1.51
6	94.6	93.8	-0.8	0.63	2.14
7	98.1	97.5	-0.6	0.69	2.82
8	101.2	100.8	-0.4	1.30	4.13
9	103.4	103.1	-0.3	2.26	6.39
10	104.9	104.1	-0.8	2.46	8.85
11	105.0	104.8	-0.2	1.60	10.44
12	104.2	103.8	-0.4	1.60	12.04
13	101.1	99.5	-1.6	0.97	13.01
14	95.3	94.6	-0.7	0.75	13.76
15	88.8	87.6	-1.2	0.44	14.20
16	84.4	83.5	-0.9	0.22	14.42
17	80.8	81.1	0.3	0.22	14.64
18	77.8	77.8	0.0	0.13	14.76
19	75.3	75.1	-0.2	0.16	14.92
20	72.0	72.2	0.2	0.06	14.98
21	70.0	70.1	0.1	0.09	15.08
22	68.2	68.1	-0.1	0.03	15.11
23	66.5	66.6	0.1	0.03	15.14
24	65.0	65.0	0.0	0.00	15.14
25	66.6	66.5	-0.1	0.06	15.20
26	72.6	72.5	-0.1	0.19	15.39
27	80.3	80.2	-0.1	0.25	15.64
28	86.1	85.8	-0.3	0.50	16.14
29	90.6	90.4	-0.2	0.81	16.96
30	94.6	94.0	-0.6	1.88	18.83
31	98.1	97.7	-0.4	2.88	21.72
32	101.2	100.5	-0.7	3.29	25.00
33	103.4	102.9	-0.5	2.98	27.98
34	104.9	104.5	-0.4	2.91	30.89
35	105.0	104.7	-0.3	1.88	32.77
36	104.2	103.9	-0.3	1.22	33.99

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
37	101.1	99.3	-1.8	0.94	34.93
38	95.3	94.8	-0.5	0.66	35.58
39	88.8	87.4	-1.4	0.28	35.86
40	84.4	83.7	-0.7	0.09	35.96
41	80.8	80.6	-0.2	0.00	35.96
42	77.8	77.5	-0.3	0.00	35.96
43	75.3	75.6	0.3	0.00	35.96
44	72	72.1	0.1	0.00	35.96
45	70	70	0	-0.09	35.86
46	68.2	68.4	0.2	0.00	35.86
47	66.5	66.6	0.1	-0.09	35.77
48	65	65.2	0.2	0.00	35.77
49	66.6	66.6	0	-0.09	35.68
50	72.6	72.4	-0.2	0.00	35.68
51	80.3	79.8	-0.5	0.38	36.05
52	86.1	85.9	-0.2	0.47	36.52
53	90.6	90.4	-0.2	0.84	37.37
54	94.6	94.2	-0.4	1.88	39.24
55	98.1	97.6	-0.5	2.91	42.15
56	101.2	100.8	-0.4	3.19	45.34
57	103.4	102.8	-0.6	2.82	48.16
58	104.9	104.6	-0.3	3.28	51.44
59	105	104.6	-0.4	1.69	53.13
60	104.2	104	-0.2	1.41	54.54
61	101.1	99.6	-1.5	0.84	55.38
62	95.3	94.6	-0.7	0.47	55.85
63	88.8	87.9	-0.9	0.28	56.13
64	84.4	83.8	-0.6	0.00	56.13
65	80.8	80.5	-0.3	-0.09	56.04
66	77.8	78	0.2	-0.09	55.95
67	75.3	75.6	0.3	-0.09	55.85
68	72	72.2	0.2	-0.19	55.66
69	70	69.9	-0.1	-0.28	55.38
70	68.2	68.3	0.1	-0.09	55.29
71	66.5	66.4	-0.1	-0.09	55.20
72	65	65.1	0.1	-0.19	55.01
Average Temperature Error (°F):			-0.41		

Automotive Testing Laboratories, Inc.

Test Date: 8/20/93
Test Fuel: Phase 2
Vehicle: 12

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
Initial	65.0	65.5	0.5	--	--
1	66.6	66.7	0.1	0.22	0.22
2	72.6	72.8	0.2	0.22	0.44
3	80.3	80.2	-0.1	0.22	0.65
4	86.1	86.0	-0.1	0.30	0.95
5	90.6	90.3	-0.3	0.35	1.30
6	94.6	93.9	-0.7	0.40	1.69
7	98.1	97.7	-0.4	0.47	2.16
8	101.2	100.4	-0.8	0.47	2.63
9	103.4	102.9	-0.5	0.59	3.22
10	104.9	104.2	-0.7	0.77	3.99
11	105.0	104.6	-0.4	0.91	4.91
12	104.2	103.7	-0.5	0.63	5.53
13	101.1	99.5	-1.6	0.59	6.12
14	95.3	94.8	-0.5	0.49	6.61
15	88.8	87.7	-1.1	0.31	6.91
16	84.4	83.6	-0.8	0.17	7.08
17	80.8	80.7	-0.1	0.14	7.22
18	77.8	78.0	0.2	0.11	7.33
19	75.3	75.2	-0.1	0.10	7.44
20	72.0	71.9	-0.1	0.07	7.50
21	70.0	70.0	0.0	0.07	7.57
22	68.2	68.2	0.0	0.07	7.63
23	66.5	66.7	0.2	0.02	7.65
24	65.0	65.0	0.0	0.11	7.76
25	66.6	66.5	-0.1	0.06	7.82
26	72.6	72.5	-0.1	0.16	7.98
27	80.3	80.0	-0.3	0.19	8.16
28	86.1	85.4	-0.7	0.50	8.66
29	90.6	90.0	-0.6	0.56	9.22
30	94.6	94.0	-0.6	0.97	10.19
31	98.1	97.7	-0.4	1.71	11.90
32	101.2	100.5	-0.7	2.21	14.11
33	103.4	103.0	-0.4	2.65	16.75
34	104.9	104.2	-0.7	2.27	19.03
35	105.0	104.6	-0.4	1.93	20.96
36	104.2	103.5	-0.7	1.21	22.17

Hour	SHED Temperature, °F Target	Actual	error	HC, grams Net (hour)	Cumulative
37	101.1	99.4	-1.7	0.78	22.95
38	95.3	94.7	-0.6	0.56	23.51
39	88.8	87.8	-1	0.22	23.73
40	84.4	84.2	-0.2	0.09	23.82
41	80.8	80.4	-0.4	-0.03	23.79
42	77.8	77.7	-0.1	0.00	23.79
43	75.3	75.4	0.1	0.00	23.79
44	72	71.9	-0.1	-0.06	23.73
45	70	69.9	-0.1	-0.03	23.70
46	68.2	68.4	0.2	-0.06	23.63
47	66.5	66.5	0	-0.06	23.57
48	65	65	0	-0.03	23.54
49	66.6	66.8	0.2	0.00	23.54
50	72.6	72.2	-0.4	0.12	23.67
51	80.3	80	-0.3	0.13	23.80
52	86.1	85.5	-0.6	0.56	24.36
53	90.6	90.2	-0.4	0.65	25.01
54	94.6	93.9	-0.7	1.21	26.22
55	98.1	97.6	-0.5	1.59	27.81
56	101.2	100.5	-0.7	2.61	30.42
57	103.4	102.9	-0.5	2.71	33.13
58	104.9	104.3	-0.6	2.15	35.27
59	105	104.3	-0.7	1.87	37.14
60	104.2	103.9	-0.3	1.31	38.45
61	101.1	99.5	-1.6	0.75	39.19
62	95.3	95	-0.3	0.47	39.66
63	88.8	88.8	0	0.19	39.85
64	84.4	84.5	0.1	-0.09	39.75
65	80.8	80.9	0.1	-0.09	39.66
66	77.8	78	0.2	-0.19	39.47
67	75.3	75.3	0	-0.09	39.38
68	72	72.1	0.1	-0.19	39.19
69	70	70	0	-0.19	39.01
70	68.2	68.2	0	-0.09	38.91
71	66.5	66.5	0	-0.09	38.82
72	65	65	0	-0.19	38.63

Average Temperature Error (°F): -0.33

Automotive Testing Laboratories, Inc.

Test Date: 8/6/93
Test Fuel: SBE
Vehicle: 12

	SHED Temperature, °F			HC, grams			SHED Temperature, °F			HC, grams	
Hour	Target	Actual	error	Net (hour)	Cumulative	Hour	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.2	-0.8	--	--	37	101.1	99.9	-1.2	0.75	35.20
1	66.6	66.6	0.0	0.27	0.27	38	95.3	95.3	0	0.19	35.38
2	72.6	72.6	0.0	0.23	0.50	39	88.8	87.9	-0.9	0.09	35.48
3	80.3	79.9	-0.4	0.26	0.76	40	84.4	83.7	-0.7	0.00	35.48
4	86.1	85.7	-0.4	0.32	1.08	41	80.8	80.9	0.1	-0.09	35.38
5	90.6	90.2	-0.4	0.38	1.46	42	77.8	77.7	-0.1	0.00	35.38
6	94.6	94.1	-0.5	0.43	1.89	43	75.3	75.1	-0.2	-0.09	35.29
7	98.1	97.6	-0.5	0.57	2.46	44	72	72	0	-0.09	35.20
8	101.2	100.5	-0.7	1.39	3.85	45	70	69.9	-0.1	-0.09	35.10
9	103.4	102.8	-0.6	2.52	6.37	46	68.2	68.3	0.1	-0.09	35.01
10	104.9	104.5	-0.4	2.69	9.06	47	66.5	66.6	0.1	-0.09	34.91
11	105.0	104.6	-0.4	2.38	11.44	48	65	65.1	0.1	-0.09	34.82
12	104.2	103.8	-0.4	1.28	12.73	49	66.6	66.5	-0.1	-0.09	34.73
13	101.1	100.1	-1.0	0.78	13.51	50	72.6	72.2	-0.4	0.09	34.82
14	95.3	95.4	0.1	0.41	13.91	51	80.3	79.6	-0.7	0.47	35.29
15	88.8	87.9	-0.9	0.25	14.17	52	86.1	85.9	-0.2	0.47	35.76
16	84.4	83.9	-0.5	0.19	14.35	53	90.6	90.1	-0.5	0.94	36.70
17	80.8	80.9	0.1	0.13	14.48	54	94.6	94.1	-0.5	2.06	38.76
18	77.8	77.7	-0.1	0.09	14.57	55	98.1	97.8	-0.3	2.91	41.67
19	75.3	75.2	-0.1	0.09	14.67	56	101.2	100.7	-0.5	2.81	44.48
20	72.0	71.9	-0.1	0.09	14.76	57	103.4	103.1	-0.3	3.28	47.77
21	70.0	70.2	0.2	0.03	14.79	58	104.9	104.4	-0.5	3.00	50.77
22	68.2	68.1	-0.1	0.03	14.82	59	105	104.7	-0.3	2.35	53.11
23	66.5	66.9	0.4	0.03	14.85	60	104.2	103.6	-0.6	1.41	54.52
24	65.0	65.0	0.0	0.00	14.85	61	101.1	99.7	-1.4	0.75	55.27
25	66.6	66.4	-0.2	0.06	14.92	62	95.3	95.5	0.2	0.00	55.27
26	72.6	72.4	-0.2	0.13	15.04	63	88.8	87.8	-1	0.09	55.36
27	80.3	80.2	-0.1	0.31	15.35	64	84.4	83.8	-0.6	-0.09	55.27
28	86.1	85.6	-0.5	0.47	15.82	65	80.8	80.7	-0.1	-0.28	54.99
29	90.6	90.3	-0.3	1.00	16.83	66	77.8	77.8	0	-0.09	54.90
30	94.6	94.2	-0.4	2.00	18.83	67	75.3	75.7	0.4	-0.28	54.61
31	98.1	98.1	0.0	2.75	21.58	68	72	72	0	-0.09	54.52
32	101.2	100.6	-0.6	3.10	24.68	69	70	69.9	-0.1	-0.19	54.33
33	103.4	102.8	-0.6	3.20	27.88	70	68.2	68.1	-0.1	-0.28	54.05
34	104.9	104.3	-0.6	2.91	30.79	71	66.5	66.6	0.1	-0.19	53.86
35	105.0	104.8	-0.2	2.16	32.94	72	65	64.9	-0.1	-0.09	53.77
36	104.2	103.8	-0.4	1.50	34.45	Average Temperature Error (°F):			-0.30		

Automotive Testing Laboratories, Inc.

Test Date: 12/21/93
Test Fuel: Base
Vehicle: 13a

Hour	SHED Temperature, °F			HC, grams		Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative		Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.5	-0.5	--	--	37	101.1	100.8	-0.3	0.57	24.03
1	66.6	66.4	-0.2	0.25	0.25	38	95.3	95.2	-0.1	0.16	24.19
2	72.6	72.4	-0.2	0.21	0.46	39	88.8	88.8	0	-0.03	24.16
3	80.3	80.0	-0.3	0.24	0.70	40	84.4	84.5	0.1	-0.06	24.10
4	86.1	85.8	-0.3	0.29	0.98	41	80.8	81	0.2	-0.09	24.00
5	90.6	90.0	-0.6	0.32	1.30	42	77.8	77.8	0	-0.13	23.88
6	94.6	93.7	-0.9	0.35	1.65	43	75.3	75.5	0.2	-0.06	23.81
7	98.1	96.6	-1.5	0.38	2.03	44	72	72	0	-0.06	23.75
8	101.2	98.5	-2.7	0.39	2.41	45	70	70	0	-0.09	23.65
9	103.4	101.8	-1.6	0.32	2.74	46	68.2	68.2	0	-0.13	23.53
10	104.9	104.6	-0.3	0.54	3.28	47	66.5	66.5	0	-0.06	23.46
11	105.0	104.5	-0.5	1.20	4.47	48	65	65	0	-0.13	23.34
12	104.2	103.6	-0.6	0.96	5.43	49	66.6	66.6	0	-0.06	23.27
13	101.1	100.7	-0.4	0.50	5.93	50	72.6	72.1	-0.5	0.03	23.31
14	95.3	95.3	0.0	0.28	6.21	51	80.3	80	-0.3	0.32	23.62
15	88.8	88.9	0.1	0.13	6.34	52	86.1	85.3	-0.8	0.38	24.00
16	84.4	84.3	-0.1	0.09	6.43	53	90.6	90.1	-0.5	0.63	24.63
17	80.8	80.8	0.0	0.04	6.47	54	94.6	94	-0.6	0.70	25.33
18	77.8	77.9	0.1	0.03	6.49	55	98.1	97.2	-0.9	1.46	26.79
19	75.3	75.4	0.1	0.02	6.51	56	101.2	99.5	-1.7	3.45	30.23
20	72.0	72.0	0.0	0.02	6.53	57	103.4	103.1	-0.3	3.99	34.23
21	70.0	70.1	0.1	-0.02	6.51	58	104.9	103.6	-1.3	4.18	38.41
22	68.2	68.2	0.0	0.01	6.52	59	105	104.6	-0.4	3.04	41.45
23	66.5	66.5	0.0	0.00	6.52	60	104.2	103.7	-0.5	1.62	43.07
24	65.0	65.0	0.0	0.01	6.53	61	101.1	100.7	-0.4	0.48	43.55
25	66.6	66.6	0.0	0.05	6.58	62	95.3	95.4	0.1	0.10	43.64
26	72.6	72.2	-0.4	0.09	6.67	63	88.8	89	0.2	0.00	43.64
27	80.3	80.1	-0.2	0.28	6.95	64	84.4	84.5	0.1	-0.57	43.07
28	86.1	85.5	-0.6	0.31	7.26	65	80.8	80.8	0	-0.29	42.79
29	90.6	90.0	-0.6	0.57	7.83	66	77.8	77.9	0.1	-0.19	42.60
30	94.6	94.0	-0.6	0.70	8.53	67	75.3	75.3	0	-0.38	42.22
31	98.1	97.1	-1.0	0.89	9.42	68	72	72	0	-0.19	42.03
32	101.2	99.4	-1.8	2.28	11.70	69	70	70.1	0.1	-0.19	41.83
33	103.4	102.7	-0.7	3.29	14.99	70	68.2	68.2	0	-0.29	41.55
34	104.9	104.1	-0.8	4.05	19.04	71	66.5	66.5	0	-0.10	41.45
35	105.0	104.5	-0.5	3.07	22.10	72	65	65.1	0.1	-0.19	41.26
36	104.2	103.6	-0.6	1.36	23.46	Average Temperature Error (°F):			-0.35		

Automotive Testing Laboratories, Inc.

Test Date: 12/13/93
Test Fuel: Phase 1
Vehicle: 13a

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.6	-0.4	--	--
1	66.6	66.6	0.0	0.24	0.24
2	72.6	71.9	-0.7	0.18	0.42
3	80.3	80.1	-0.2	0.26	0.67
4	86.1	85.5	-0.6	0.30	0.97
5	90.6	90.2	-0.4	0.31	1.28
6	94.6	94.0	-0.6	0.36	1.65
7	98.1	97.5	-0.6	0.35	1.99
8	101.2	100.2	-1.0	0.46	2.46
9	103.4	102.5	-0.9	0.40	2.86
10	104.9	104.2	-0.7	0.50	3.36
11	105.0	104.3	-0.7	0.45	3.82
12	104.2	103.1	-1.1	0.59	4.40
13	101.1	100.7	-0.4	0.27	4.67
14	95.3	95.0	-0.3	0.26	4.93
15	88.8	88.7	-0.1	0.18	5.12
16	84.4	84.4	0.0	0.12	5.23
17	80.8	80.7	-0.1	0.04	5.27
18	77.8	77.8	0.0	0.04	5.31
19	75.3	75.3	0.0	0.01	5.32
20	72.0	72.2	0.2	0.02	5.34
21	70.0	70.0	0.0	0.00	5.34
22	68.2	68.2	0.0	0.00	5.34
23	66.5	66.5	0.0	0.00	5.34
24	65.0	65.3	0.3	0.00	5.34
25	66.6	66.6	0.0	0.03	5.37
26	72.6	72.4	-0.2	0.09	5.45
27	80.3	80.0	-0.3	0.20	5.66
28	86.1	85.9	-0.2	0.27	5.93
29	90.6	90.5	-0.1	0.41	6.34
30	94.6	94.2	-0.4	0.30	6.64
31	98.1	97.7	-0.4	0.37	7.01
32	101.2	100.6	-0.6	0.60	7.60
33	103.4	102.8	-0.6	0.19	7.79
34	104.9	104.1	-0.8	0.51	8.31
35	105.0	104.8	-0.2	0.74	9.05
36	104.2	103.5	-0.7	0.61	9.66

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	100.6	-0.5	0.55	10.20
38	95.3	95.3	0	0.10	10.30
39	88.8	88.6	-0.2	0.10	10.40
40	84.4	84.5	0.1	-0.10	10.30
41	80.8	80.8	0	-0.03	10.27
42	77.8	77.9	0.1	-0.03	10.24
43	75.3	75.3	0	-0.10	10.14
44	72	72	0	0.00	10.14
45	70	70	0	-0.13	10.01
46	68.2	68.3	0.1	-0.03	9.98
47	66.5	66.7	0.2	-0.06	9.92
48	65	65	0	-0.06	9.85
49	66.6	66.6	0	-0.03	9.82
50	72.6	72.3	-0.3	0.06	9.88
51	80.3	79.4	-0.9	0.32	10.20
52	86.1	86	-0.1	0.55	10.75
53	90.6	90.5	-0.1	0.55	11.30
54	94.6	94.2	-0.4	0.74	12.04
55	98.1	97.5	-0.6	0.84	12.87
56	101.2	100.2	-1	1.29	14.16
57	103.4	102.7	-0.7	1.54	15.70
58	104.9	104.2	-0.7	3.86	19.56
59	105	104.5	-0.5	0.64	20.20
60	104.2	103.7	-0.5	1.12	21.32
61	101.1	100.4	-0.7	0.58	21.90
62	95.3	95.2	-0.1	0.19	22.09
63	88.8	88.8	0	-0.10	22.00
64	84.4	84.2	-0.2	-0.06	21.93
65	80.8	80.6	-0.2	-0.26	21.68
66	77.8	78	0.2	-0.16	21.52
67	75.3	75.3	0	-0.19	21.32
68	72	72	0	-0.16	21.16
69	70	69.7	-0.3	-0.22	20.94
70	68.2	68.4	0.2	-0.13	20.81
71	66.5	66.7	0.2	-0.10	20.71
72	65	65.1	0.1	-0.10	20.62
Average Temperature Error (°F):			-0.27		

Automotive Testing Laboratories, Inc.

Test Date: 11/29/93
Test Fuel: Phase 2
Vehicle: 13a

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
Initial	65.0	64.5	-0.5	--	--
1	66.6	66.6	0.0	0.07	0.07
2	72.6	72.3	-0.3	0.06	0.13
3	80.3	80.3	0.0	0.08	0.21
4	86.1	85.5	-0.6	0.11	0.32
5	90.6	89.8	-0.8	0.13	0.45
6	94.6	94.0	-0.6	0.15	0.60
7	98.1	97.6	-0.5	0.19	0.79
8	101.2	100.5	-0.7	0.20	0.99
9	103.4	102.8	-0.6	0.22	1.21
10	104.9	104.5	-0.4	0.21	1.42
11	105.0	104.8	-0.2	0.25	1.67
12	104.2	103.6	-0.6	0.23	1.91
13	101.1	100.6	-0.5	0.22	2.12
14	95.3	95.3	0.0	0.16	2.28
15	88.8	88.8	0.0	0.12	2.41
16	84.4	84.3	-0.1	0.08	2.48
17	80.8	80.8	0.0	0.06	2.54
18	77.8	77.8	0.0	0.05	2.60
19	75.3	75.4	0.1	0.04	2.64
20	72.0	72.0	0.0	0.03	2.67
21	70.0	70.0	0.0	0.03	2.70
22	68.2	68.2	0.0	0.05	2.75
23	66.5	66.5	0.0	0.02	2.76
24	65.0	65.0	0.0	-0.07	2.69
25	66.6	66.6	0.0	0.03	2.72
26	72.6	72.7	0.1	0.07	2.79
27	80.3	80.3	0.0	0.11	2.89
28	86.1	86.1	0.0	0.14	3.03
29	90.6	90.6	0.0	0.16	3.20
30	94.6	94.0	-0.6	0.18	3.38
31	98.1	98.1	0.0	0.21	3.59
32	101.2	100.8	-0.4	0.23	3.82
33	103.4	103.1	-0.3	0.24	4.06
34	104.9	104.3	-0.6	0.24	4.30
35	105.0	104.8	-0.2	0.27	4.57
36	104.2	103.5	-0.7	0.29	4.85

Hour	SHED Temperature, °F			HC, grams	
	Target	Actual	error	Net (hour)	Cumulative
37	101.1	100.6	-0.5	0.19	5.04
38	95.3	95.3	0	0.14	5.19
39	88.8	88.4	-0.4	0.10	5.28
40	84.4	84.4	0	0.07	5.35
41	80.8	80.7	-0.1	0.02	5.37
42	77.8	77.9	0.1	0.04	5.41
43	75.3	75.3	0	-0.02	5.39
44	72	72	0	0.01	5.40
45	70	70	0	0.00	5.40
46	68.2	68	-0.2	0.00	5.40
47	66.5	66.5	0	0.00	5.40
48	65	65	0	0.00	5.40
49	66.6	66.6	0	0.03	5.43
50	72.6	72.3	-0.3	0.07	5.49
51	80.3	80.1	-0.2	0.14	5.64
52	86.1	86	-0.1	0.22	5.86
53	90.6	90.1	-0.5	0.25	6.11
54	94.6	94.4	-0.2	0.27	6.37
55	98.1	98.2	0.1	0.32	6.69
56	101.2	100.8	-0.4	0.36	7.05
57	103.4	103.1	-0.3	0.39	7.45
58	104.9	104.2	-0.7	0.33	7.78
59	105	104.7	-0.3	0.51	8.29
60	104.2	103.7	-0.5	0.33	8.62
61	101.1	100.6	-0.5	0.29	8.91
62	95.3	94.8	-0.5	0.18	9.09
63	88.8	89	0.2	0.03	9.12
64	84.4	84.4	0	0.02	9.14
65	80.8	80	-0.8	-0.01	9.13
66	77.8	78.1	0.3	-0.02	9.11
67	75.3	75.3	0	-0.04	9.07
68	72	72	0	0.00	9.07
69	70	70	0	-0.05	9.03
70	68.2	68.5	0.3	-0.01	9.02
71	66.5	66.5	0	-0.03	8.99
72	65	65.2	0.2	-0.03	8.96
Average Temperature Error (°F):			-0.20		

Automotive Testing Laboratories, Inc.

Test Date: 1/03/94
Test Fuel: SBE
Vehicle: 13a

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
Initial	65.0	65.0	0.0	--	--
1	66.6	66.6	0.0	0.10	0.10
2	72.6	72.1	-0.5	0.09	0.19
3	80.3	79.8	-0.5	0.11	0.30
4	86.1	85.6	-0.5	0.15	0.45
5	90.6	90.1	-0.5	0.19	0.64
6	94.6	93.9	-0.7	0.23	0.87
7	98.1	96.9	-1.2	0.26	1.13
8	101.2	99.1	-2.1	0.29	1.41
9	103.4	102.0	-1.4	0.31	1.72
10	104.9	103.1	-1.8	0.35	2.07
11	105.0	104.2	-0.8	0.33	2.41
12	104.2	103.6	-0.6	0.26	2.67
13	101.1	100.6	-0.5	0.36	3.03
14	95.3	95.0	-0.3	0.27	3.30
15	88.8	88.9	0.1	0.09	3.39
16	84.4	84.4	0.0	0.09	3.48
17	80.8	80.8	0.0	0.06	3.54
18	77.8	77.8	0.0	0.06	3.59
19	75.3	75.3	0.0	0.03	3.62
20	72.0	72.0	0.0	0.03	3.65
21	70.0	70.1	0.1	0.01	3.66
22	68.2	68.3	0.1	0.02	3.68
23	66.5	66.5	0.0	0.01	3.69
24	65.0	65.0	0.0	0.00	3.69
25	66.6	66.6	0.0	0.03	3.71
26	72.6	72.2	-0.4	0.07	3.79
27	80.3	79.6	-0.7	0.16	3.94
28	86.1	85.5	-0.6	0.22	4.16
29	90.6	90.0	-0.6	0.27	4.43
30	94.6	93.9	-0.7	0.31	4.75
31	98.1	97.2	-0.9	0.32	5.07
32	101.2	99.2	-2.0	0.34	5.41
33	103.4	102.1	-1.3	0.41	5.82
34	104.9	103.3	-1.6	0.42	6.24
35	105.0	104.4	-0.6	0.47	6.71
36	104.2	103.6	-0.6	0.45	7.16

Hour	SHED Temperature, °F Target	SHED Temperature, °F Actual	SHED Temperature, °F error	HC, grams Net (hour)	HC, grams Cumulative
37	101.1	100.6	-0.5	0.33	7.50
38	95.3	95.3	0	0.22	7.72
39	88.8	88.8	0	0.09	7.81
40	84.4	84.6	0.2	0.00	7.81
41	80.8	80.8	0	-0.01	7.80
42	77.8	77.8	0	-0.02	7.78
43	75.3	75.3	0	-0.03	7.75
44	72	72	0	-0.05	7.71
45	70	70	0	-0.06	7.65
46	68.2	68.3	0.1	-0.05	7.61
47	66.5	66.6	0.1	-0.06	7.55
48	65	65.2	0.2	-0.04	7.51
49	66.6	66.5	-0.1	0.02	7.53
50	72.6	72.2	-0.4	0.11	7.64
51	80.3	79.5	-0.8	0.23	7.87
52	86.1	86	-0.1	0.14	8.01
53	90.6	89.8	-0.8	0.37	8.38
54	94.6	94.3	-0.3	0.43	8.81
55	98.1	97.2	-0.9	0.52	9.34
56	101.2	99.6	-1.6	0.65	9.98
57	103.4	102	-1.4	0.74	10.72
58	104.9	103.6	-1.3	1.08	11.80
59	105	104.6	-0.4	1.05	12.84
60	104.2	103.8	-0.4	0.80	13.64
61	101.1	100.7	-0.4	0.43	14.08
62	95.3	95.3	0	0.15	14.23
63	88.8	88.8	0	0.03	14.26
64	84.4	84.5	0.1	-0.06	14.20
65	80.8	80.9	0.1	-0.06	14.14
66	77.8	77.8	0	-0.18	13.95
67	75.3	75.3	0	-0.15	13.80
68	72	72.2	0.2	-0.12	13.68
69	70	70	0	-0.15	13.52
70	68.2	68.3	0.1	-0.12	13.40
71	66.5	66.5	0	-0.09	13.31
72	65	65	0	-0.09	13.21

Average Temperature Error (°F): -0.40

Automotive Testing Laboratories, Inc.